SOIL SURVEY OF

Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties, Michigan

United States Department of Agriculture
Soil Conservation Service and Forest Service
In cooperation with
Michigan Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1958–67. Soil names and descriptions were approved in 1967. Unless otherwise indicated, statements in the publication refer to conditions in the counties in 1967. This survey was made cooperatively by the Soil Conservation Service, the Forest Service, and the Michigan Agricultural Experiment Station. It is part of the technical assistance furnished to the Delta Counties, Alger, and Schoolcraft Soil and Water Conservation Districts.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, recreation, woodland, and wildlife habitat.

Locating Soils

All the soils of the survey area are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the woodland suitability group and recreation group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and woodland suitability groups.

Foresters and others can refer to the section "Woodland," where the soils of the area are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Town and Country Planning."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in the survey area will be especially interested in the "General Soil Map," where broad patterns of soils are described. They will also be interested in the information about the area given at the beginning of the publication and in the section "General Nature of the Area" at the end of the survey.

Cover: Northern hardwood forest in an area of a Munising sandy loam.

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SOIL SURVEY OF DELTA COUNTY AND HIAWATHA NATIONAL FOREST OF ALGER AND SCHOOLCRAFT COUNTIES, MICHIGAN

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE AND FOREST SERVICE, IN COOPERATION WITH MICHIGAN AGRICULTURAL EXPERIMENT STATION

DELTA COUNTY AND HIAWATHA NATIONAL FOREST OF ALGER AND SCHOOLCRAFT COUNTIES are located in the central part of the Upper Peninsula of Michigan (fig. 1). The survey area is bordered on the north by Lake Superior and on the south by Lake Michigan. It has a total area of about 1,131,275 acres, or 1,768 square miles. Escanaba is the largest city in the survey area, and Munising is the second largest.

Nearly 90 percent of the survey area is wooded. Most of the wooded acreage is in National Forest or is owned by the State of Michigan and several large corporations. Producing forest products and providing recreational facilities are the major industries. Many residents of the area are employed in forestry or in paper mills and other industries, mainly in Escanaba, Munising, and Gladstone.

The main farming area is located west of the Escanaba River. Dairying and raising beef are the chief livestock enterprises. Hay, corn for silage, and small grain are produced to feed livestock. Potatoes is the main cash crop. Beans and strawberries are also grown.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties, where they are located, and how they can be used. The soil scientists went into the area knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide,

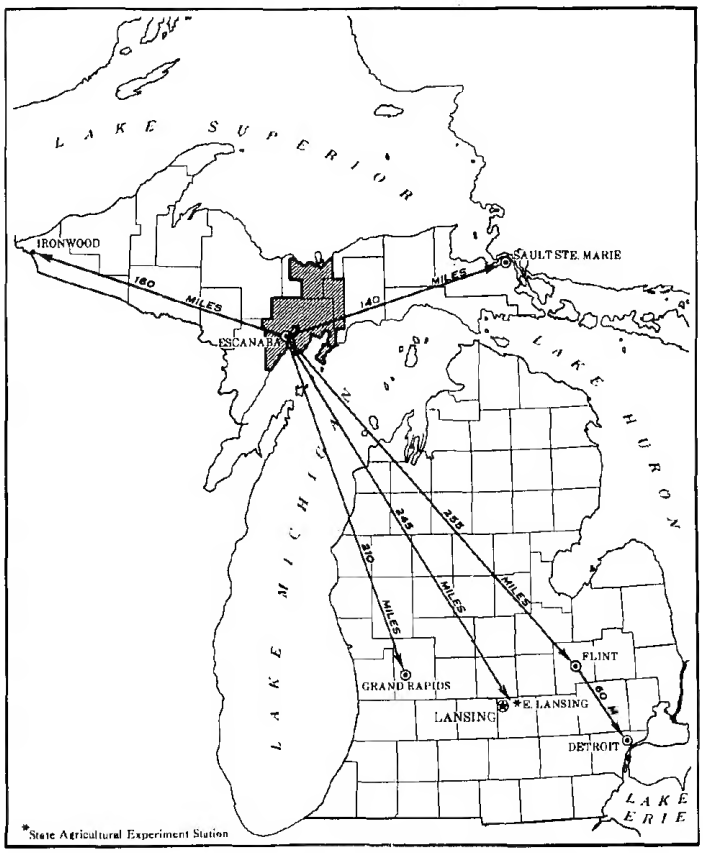

Figure 1.—**Location of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties in Michigan.**

[1] Others who contributed to the fieldwork were ALBERT HOSNER, ROBERT JOHNSON, and DELBERT MEISTER, Soil Conservation Service; CHARLES CHRISTOPH, DAVID SCHOLL, DONALD PRETTYMAN, GRANT GOLTZ, WILLIAM MORIARITY, and TOM COLLINS, Forest Service; and BRUCE RAE, LYLE LINSEMIER, ALLEN BAILEY, and AUBREY MESSENGER, Michigan Agricultural Experiment Station.

uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Munising and Trenary, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Munising sandy loam, 0 to 6 percent slopes, is one of several phases within the Munising series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Eastport-Roscommon sands, 0 to 6 percent slopes, is a complex in this survey area.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Ensley and Angelica soils, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Borrow pits is a land type in this survey area.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm and forest records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, foresters, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties are discussed in the following pages. They are grouped according to their dominant texture and their position on the landscape.

Dominantly Sandy Soils of the Outwash Plains, Lake Plains, and Moraines

In this group of associations are nearly level to very steep, well drained or moderately well drained soils on outwash plains, lake plains, and moraines. The soils

formed mainly in sandy material. Some soils have a loamy subsoil.

All these associations are used mainly as woodland and for recreation. These associations are generally poorly suited to crops, because the soils are droughty and have low fertility.

Three soil associations are in this group. They make up 29 percent of the survey area.

1. Rubicon association

Nearly level to very steep, well-drained, sandy soils

This association consists mainly of nearly level or gently sloping soils on outwash plains and lake plains. It also consists of sloping to very steep soils on moraines. The very steep soils have short slopes.

This association occupies about 10 percent of the survey area. Rubicon soils make up about 75 percent of the association, and minor soils make up the remaining 25 percent.

Rubicon soils are well drained. They have a surface layer of black sand about 1 inch thick and a subsurface layer of brown sand about 3 inches thick. The subsoil is reddish-brown and brown sand. Light-brown sand is at a depth of about 27 inches.

Minor soils in this association are in the Au Gres, Croswell, Grayling, and Roscommon series. Au Gres soils are nearly level or gently sloping and are somewhat poorly drained. Croswell soils are nearly level or gently sloping and are moderately well drained. Roscommon soils are nearly level and poorly drained. They form a drainage sequence with Rubicon soils and commonly occupy depressional areas within large areas of Rubicon soils. The well-drained Grayling soils are nearly level to moderately steep. The areas of Grayling soils are only on the northeast and northwest shores of Little Bay de Noc.

All the soils in this association have low fertility. Available water capacity is very low. The major limitations to the use and management of these soils are droughtiness, low fertility, and soil blowing. The Rubicon, Grayling, and Croswell soils are subject to soil blowing and wetness. Low fertility and hazard of frost are limitations to use of the Au Gres and Roscommon soils.

This association is used as woodland and for recreation. Some of the areas that were formerly cleared are idle or are planted to pines. Pine trees grow well on soils of this association. Most of the association is in pines (fig. 2).

2. Kalkaska association

Nearly level to very steep, well drained and moderately well drained, sandy soils

This association consists of soils on outwash plains and moraines. Most of the soils of this association are nearly level to gently sloping.

This association occupies about 14 percent of the survey area. Kalkaska soils make up about 80 percent of this association, and minor soils make up the remaining 20 percent.

Kalkaska soils are well drained or moderately well drained. The surface layer typically is black forest litter about 2 inches thick. The subsurface layer is pinkish-gray sand about 10 inches thick. The subsoil is dark reddish-brown and strong-brown sand. Light-brown sand is at a depth of about 27 inches.

***Figure 2.*—A natural stand of red pine trees in an area of a Rubicon sand.**

Minor soils in this association are in the Blue Lake, Karlin, Rubicon, and Wallace series. Blue Lake soils are nearly level to very steep, well-drained, sandy soils that have loamy bands in the lower part of the subsoil. Karlin soils are nearly level to moderately steep, well-drained soils that formed in 15 to 40 inches of loamy material overlying sandy material. Rubicon soils are well-drained, sandy soils. Wallace soils are well drained or moderately well drained, sandy soils that have a cemented subsoil. The minor soils are in areas throughout the association.

Kalkaska soils have low fertility and very low available water capacity. The minor soils generally are low in fertility, but the Karlin soils are medium. Most of the minor soils have very low to low available water capacity. The major limitations to the use and management of most of the soils in this association are low fertility, droughtiness, and the hazard of soil blowing.

This association is used as woodland and for recreation. Some of the areas that were formerly cleared for pasture or crops are idle or are planted to pines. Pine trees grow well on soils of this association. Most of the association is in hardwoods (fig. 3).

3. *Karlin-Blue Lake association*

Nearly level to very steep, well-drained, loamy and sandy soils

This association consists mostly of soils on moraines. A small part of the association is on outwash plains.

This association occupies about 5 percent of the survey area. Karlin soils make up about 35 percent of this association, Blue Lake soils make up 30 percent, and minor soils make up the remaining 35 percent.

Karlin soils are nearly level to moderately steep and are well drained. The surface layer typically is black forest litter about 2 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is dark reddish-brown or reddish-brown sandy loam in the upper part and dark-brown loamy sand in the lower part. Brown sand is at a depth of about 22 inches.

Blue Lake soils are nearly level to very steep and are well drained. The surface layer is black sand about 1 inch thick. The subsurface layer is reddish-gray sand about 9 inches thick. The subsoil is dark reddish-brown and yellowish-red sand in the upper part and brown sand and reddish-brown fine sandy loam in the lower part. Light-brown sand that has many bands of reddish-brown loamy sand in the upper part is at a depth of about 32 inches.

Minor soils in this association are in the Au Gres, Kalkaska, Keweenaw, and Steuben series. Au Gres soils are nearly level or gently sloping, somewhat poorly drained, sandy soils. Kalkaska soils are nearly level to very steep, well drained or moderately well drained, sandy soils. Keweenaw soils are nearly level to moderately steep, well-drained, dominantly sandy soils. Steuben soils are nearly level to moderately steep, well drained or moderately well drained soils that have a dominantly loamy subsoil overlying sand. Most of the minor soils are present throughout the association, but the Keweenaw and Steuben soils are mainly in Alger County.

Karlin soils and Steuben soils are medium in natural fertility. They have moderate available water capacity

Figure 3.—A stand of northern hardwoods in an area of Kalkaska soils.

in the loamy layer and low or very low available water capacity in the sandy layer. Blue Lake, Au Gres, and Kalkaska soils have low fertility and low to very low available water capacity. The major limitations to the use and management of the soils in this association are low fertility, droughtiness, soil blowing, and the hazard of water erosion.

Nearly all this association is used as woodland and for recreation. Northern hardwoods are the main wood crop. Red pine trees grow well on the soils of this association. Some areas are cleared, but the cleared areas are mostly idle or are used for pasture. A few areas are cultivated and are used for small grain, hay, and pasture.

Dominantly Loamy Soils of the Till Plains and Moraines

In this group of associations are nearly level to very steep, well drained or moderately well drained soils on till plains and moraines. The soils formed mainly in loamy material. Some of the soils have a sandy substratum, and some are organic.

These associations make up the largest acreage of farmland in the survey area. A large acreage of this group is used as woodland and for recreation. The soils in these associations are better suited to crops than are the other soils in the survey area.

Three soil associations are in this group. They make up 18 percent of the survey area.

4. Munising-Steuben association

Nearly level to very steep, well drained and moderately well drained, dominantly loamy soils

This association consists of dominantly loamy soils and of loamy soils that are underlain by sandy layers on moraines and till plains. Most of the soils of this association are gently sloping to sloping.

This association occupies about 4 percent of the survey area. Munising soils make up about 44 percent of this association, Steuben soils make up 18 percent, and minor soils make up the remaining 38 percent.

Munising soils are nearly level to very steep and are well drained or moderately well drained. They have a surface layer of black sandy loam about 1 inch thick. The subsurface layer is pinkish-gray sandy loam about 5 inches thick. The upper part of the subsoil is dark reddish-brown to reddish-brown sandy loam. The lower part of the subsoil is firm, light reddish-brown loamy sand and reddish-brown sandy loam. Reddish-brown sandy loam is at a depth of about 46 inches.

Steuben soils are nearly level to moderately steep and are well drained or moderately well drained. They have a surface layer of black forest litter about 2 inches thick. The subsurface layer is reddish-gray fine sandy loam about 6 inches thick. The upper part of the subsoil is dark reddish-brown and dark-brown fine sandy loam. The lower part of the subsoil is firm, pinkish-gray, loamy fine sand and reddish-brown fine sandy loam. Light-brown sand is at a depth of about 38 inches.

Minor soils in this association are in the Blue Lake, Keweenaw, Onota, Deerton, and Skanee series. Blue Lake soils and Keweenaw soils are nearly level to very steep, well-drained, dominantly sandy soils that have a loamy layer in the lower part of the subsoil. They are present throughout the association. Onota soils are nearly level to very steep, well drained or moderately well drained, dominantly loamy soils overlying sandstone bedrock at a depth of 20 to 40 inches. Deerton soils are nearly level to moderately steep, well drained or moderately well drained, sandy soils overlying sandstone at a depth of 20 to 40 inches. Onota soils and Deerton soils are mainly near Lake Superior. Skanee soils are nearly level to gently sloping, somewhat poorly drained, dominantly loamy soils that are in depressions or along swamp borders.

Munising, Steuben, Onota, and Skanee soils have medium fertility and moderate available water capacity. Blue Lake, Keweenaw, and Deerton soils have low fertility and low available water capacity. The major soils in this association are limited mainly by water erosion, and the minor soils are limited mainly by droughtiness, low fertility, soil blowing, and water erosion.

Almost all of this association is used as woodland and for recreation. Northern hardwoods are the major wood crop. Several small areas have been cleared, but most are now idle. The major soils in this association are well suited to cultivated crops. Some areas are somewhat droughty. The firm subsoil in the major soils of this association restricts deep rooting of trees and increases the hazard of erosion in sloping areas.

5. Trenary-Cathro-Tacoosh association

Nearly level to moderately steep, well drained and moderately well drained, loamy soils, and nearly level, very poorly drained organic soils

This association consists of soils on till plains. Most of the soils of this association are nearly level to sloping. The moderately steep soils have short slopes.

This association occupies about 5 percent of the survey area. Trenary soils make up about 60 percent of this association, Cathro and Tacoosh soils make up 20 percent, and minor soils make up the remaining 20 percent.

Trenary soils are nearly level to moderately steep and are well drained or moderately well drained. They have a surface layer of very dark gray fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 3 inches thick. The subsoil is dark reddish-brown and reddish-brown fine sandy loam, reddish-brown light sandy loam, and dark reddish-brown sandy clay loam. Reddish-brown sandy loam is at a depth of about 37 inches.

Cathro soils are nearly level and very poorly drained. They have a surface layer of black muck about 4 inches thick. The subsurface layer is black mucky peat and black muck. Grayish-brown sandy loam is at a depth of 23 inches.

Tacoosh soils are nearly level and very poorly drained. They have a surface layer of black muck about 8 inches thick. The subsurface layer is black mucky peat, dark reddish-brown mucky peat, and very dark grayish-brown mucky peat. Grayish-brown very fine sandy loam and light brownish-gray sandy loam are at a depth of 40 inches.

Minor soils in this association are in the Charlevoix, Chatham, Ensley, Angelica, Karlin, and Longrie series. Charlevoix soils are nearly level or gently sloping, some-

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what poorly drained, loamy soils that are in transitional zones between the Trenary soils and poorly drained or very poorly drained soils. Chatham soils are nearly level to moderately steep, well drained or moderately well drained soils that have a loamy subsoil overlying gravelly and sandy material. Most areas of Chatham soils are near the village of Chatham. Ensley and Angelica soils are nearly level, poorly drained, loamy soils in depressions. Karlin soils are nearly level to moderately steep, well-drained soils that have a dominantly loamy subsoil overlying sand. Most areas of Karlin soils are in the Cooks area. Longrie soils are nearly level to moderately steep, well drained or moderately well drained, loamy soils underlain by limestone bedrock at a depth of 20 to 40 inches. Longrie soils are in areas throughout the association.

Trenary, Charlevoix, Chatham, Ensley, Angelica, Karlin, and Longrie soils have medium to high fertility and moderate to high available water capacity. Cathro and Tacoosh soils have low fertility and very high available water capacity. The major limitations to the use and management of the soils in this association are erosion on the moderately well drained or well drained soils and wetness and hazard of frost on the poorly drained soils.

About half of the upland part of this association is cleared. Hay, small grain, and potatoes are the main crops (fig. 4). Trenary soils are fertile, and they respond to good management. They are among the most suitable soils for farming in the survey area. They are also used as woodland.

Almost all of the acreage of the more poorly drained soils in this association is used as woodland. Hardwood sawlogs, aspen and conifer pulp, and cedar posts are the main wood products.

6. *Onaway-Charlevoix-Tacoosh association*

Nearly level to moderately steep, well drained to somewhat poorly drained, loamy soils, and nearly level, very poorly drained organic soils

This association consists of soils on till plains. Most of the soils are nearly level to sloping. The moderately steep soils have short slopes.

This association occupies about 9 percent of the survey area. Onaway soils make up about 30 percent of this association, Charlevoix soils make up 25 percent, Tacoosh soils make up 10 percent, and minor soils make up the remaining 35 percent.

Onaway soils are nearly level to moderately steep and are well drained or moderately well drained. They have a surface layer of black fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 1 inch thick. The subsoil is dark-brown fine sandy loam, reddish-brown sandy loam, and dark reddish-brown clay loam. Reddish-brown loam is at a depth of about 22 inches.

Charlevoix soils are nearly level or gently sloping and are somewhat poorly drained. They have a surface layer of very dark brown sandy loam about 2 inches thick. The subsurface layer is grayish-brown sandy loam about 5 inches thick. The subsoil is brown sandy loam and dark-brown loam. Brown sandy loam is at a depth of 29 inches.

Figure 4.—Potatoes in an area of Trenary fine sandy loam.

Tacoosh soils are nearly level and very poorly drained. They have a surface layer of black muck about 8 inches thick. Beneath the surface layer are layers of black, dark reddish-brown, and very dark grayish-brown mucky peat. Grayish-brown very fine sandy loam and light brownish-gray sandy loam are at a depth of 40 inches.

Minor soils in this association are in the Cathro, Carbondale, Lupton, Rifle, Emmet, Ensley, Angelica, Kawkawlin, Longrie, and Nester series. Cathro, Carbondale, Lupton, and Rifle soils are nearly level, very poorly drained organic soils. Emmet soils are nearly level to sloping, well drained or moderately well drained, loamy soils. Ensley and Angelica soils are nearly level, poorly drained, loamy soils. Kawkawlin soils are nearly level, somewhat poorly drained, loamy soils. Longrie soils are nearly level to moderately steep, well drained or moderately well drained, loamy soils underlain by limestone bedrock at a depth of 20 to 40 inches. Nester soils are nearly level or gently sloping, well drained or moderately well drained, loamy soils. Nester and Kawkawlin soils are near Garden on the Garden Peninsula. The other minor soils are present throughout the association.

Onaway, Charlevoix, Emmet, Ensley, Angelica, Kawkawlin, Longrie, and Nester soils have medium to high fertility and moderate to high available water capacity. Cathro, Tacoosh, Carbondale, Lupton, and Rifle soils have low fertility and very high available water capacity. The major limitations to the use and management of the soils in this association are water erosion on the moderately well drained or well drained soils and wetness and hazard of frost on the poorly drained soils.

Hay, small grain, potatoes, corn for silage, and specialty crops are grown on the upland soils of this association. The largest acreage of farmland in the survey area is in this association. The upland part has high potential for all cultivated crops commonly grown in the survey area. It is also used as woodland. The lowland part of this association is used mainly as woodland. Pulp and posts are wood products commonly produced from trees harvested on the wet soils.

Dominantly Loamy Soils of the Outwash Plains, Till Plains, and Bedrock Benches

In this group of associations are nearly level to steep, well drained or moderately well drained soils. These soils are on outwash plains, till plains, lake plains, and bedrock benches where limestone is near the surface. The outwash areas are underlain by limestone gravel. These soils formed mainly in loamy material. They are underlain by limestone gravel or limestone bedrock. Some soils overlying limestone bedrock are organic.

Part of the acreage in this group of associations is used for general farming. Most areas of the associations are used as woodland and for recreation. Most of the soils of this group are generally poorly suited to crops because of shallowness or droughtiness. The deeper soils are moderately well suited to well suited to crops.

The two soil associations in this group make up 7 percent of the survey area.

7. Kiva-Chippeny-Summerville association

Nearly level to steep, well drained and moderately well drained, loamy soils underlain by sand and gravel or limestone bedrock, and nearly level, very poorly drained organic soils underlain by limestone bedrock

This association consists of soils on outwash plains and till plains. These soils are shallow over sand and gravel or limestone bedrock. The steep soils have short slopes.

This association occupies about 3 percent of the survey area. Kiva soils make up about 25 percent of this association, Chippeny soils make up 20 percent, Summerville soils make up 18 percent, and minor soils make up the remaining 37 percent.

Kiva soils are nearly level to steep and are well drained. They have a surface layer of black sandy loam about 2 inches thick. The subsurface layer is brown sandy loam about 3 inches thick. The subsoil is dark reddish-brown sandy loam and dark-brown gravelly sandy loam. Stratified sand and gravel are at a depth of about 22 inches.

Chippeny soils are nearly level or gently sloping and are very poorly drained. The surface layer and second layer are black muck about 6 inches thick. The third layer is very dark gray muck about 14 inches thick. The underlying material is dark grayish-brown silty clay loam. Limestone bedrock is at a depth of 28 inches.

Summerville soils are nearly level to moderately steep and are well drained or moderately well drained. They have a surface layer of very dark gray fine sandy loam about 4 inches thick. The subsurface layer is light brownish-gray fine sandy loam about 3 inches thick. The subsoil is brown fine sandy loam. The underlying material is light reddish-brown fine sandy loam. Limestone bedrock is at a depth of 15 inches.

Minor soils in this association are in the Carbondale, Lupton, Rifle, Nahma, and Ruse series and Limestone rock land. Carbondale, Lupton, and Rifle soils are nearly level, very poorly drained, deep organic soils. Nahma soils are nearly level, poorly drained, loamy soils that are underlain by limestone bedrock at a depth of 20 to 40 inches. Ruse soils are nearly level, poorly drained, loamy soils that are underlain by limestone bedrock at a depth of 10 to 20 inches. Limestone rock land is less than 10 inches of mainly loamy soil material over limestone bedrock. The minor soils are in areas throughout the association.

Kiva, Summerville, Nahma, and Ruse soils have low or medium fertility and moderate available water capacity. Carbondale, Chippeny, Lupton, and Rifle soils have low fertility and very high available water capacity. Limestone rock land has very low available water capacity. The major limitations to the use and management of the soils in this association are shallow depth to bedrock and the hazard of erosion on the well drained or moderately well drained soils and wetness and hazard of frost on the poorly drained soils.

About one-fourth of the acreage of the well drained or moderately well drained soils in this association is cleared. Some areas of these soils are used for hay, pasture, and small grain. Many areas are idle. Most of this association is used as woodland. Aspen pulp and sawlogs from the upland areas and conifers pulp and cedar posts are the main wood products. Kiva soils in this association are a source of gravel.

8. Summerville-Limestone rock land-Longrie association

Nearly level to moderately steep, well drained and moderately well drained, loamy soils underlain by limestone bedrock

This association consists of soils on till plains and lake plains. These soils are underlain by limestone bedrock. The moderately steep areas of soils are small and have short slopes.

This association occupies about 4 percent of the survey area. Summerville soils make up about 25 percent of this association. Limestone rock land makes up 25 percent, Longrie soils make up 20 percent, and minor soils make up the remaining 30 percent.

Summerville soils are nearly level to moderately steep and are well drained or moderately well drained. They have a surface layer of very dark gray fine sandy loam about 4 inches thick. The subsurface layer is light brownish-gray fine sandy loam about 3 inches thick. The subsoil is brown fine sandy loam. The underlying material is light reddish-brown fine sandy loam. Limestone bedrock is at a depth of 15 inches.

Limestone rock land is nearly level or gently sloping and is mainly well drained. It is as much as 10 inches of loamy soil material over limestone bedrock. Some areas are very stony, and some are relatively free of stones. As much as 10 percent of the areas is exposed bedrock.

Longrie soils are nearly level to moderately steep and are well drained or moderately well drained. They have a surface layer of very dark grayish-brown sandy loam about 8 inches thick. The subsurface layer is light brownish-gray sandy loam about 2 inches thick. The subsoil is dark reddish-brown sandy loam and reddish-brown sandy loam and loam. The underlying material is light reddish-brown loam overlying limestone bedrock at a depth of 28 inches.

Minor soils in this association are in the Alpena, Chippeny, Kiva, and Sundell series. Alpena soils are nearly level to sloping, well-drained soils that have a surface layer of gravelly sandy loam and a subsoil of gravelly sandy loam underlain by sand and gravel. Chippeny soils are nearly level, very poorly drained organic soils underlain by limestone bedrock at a depth of 12 to 51 inches. Kiva soils are nearly level to steep, well-drained, loamy soils underlain by sand and gravel. Sundell soils are nearly level or gently sloping, somewhat poorly drained, loamy soils underlain by limestone bedrock at a depth of 20 to 40 inches. The Alpena soils are mainly near Lake Michigan. The other minor soils are in areas throughout the association.

The Summerville, Longrie, and Sundell soils have medium to high fertility and moderate to high available water capacity. Alpena and Chippeny soils have low fertility. Available water capacity is very low in Alpena soils and very high in Chippeny soils. Limestone rock land has medium fertility and very low available water capacity. Major limitations to the use and management of the soils of this association are the hazard of erosion and stoniness. Other limitations are droughtiness on Alpena soils and Limestone rock land and wetness and hazard of frost on Chippeny and Sundell soils. The hazard of erosion is slight on Longrie soils.

More than half of the acreage of Summerville and Longrie soils has been cleared. Many acres are idle. Areas being farmed are used for hay, pasture, small grain, and beans. Some areas of Limestone rock land are used for pasture, but most areas are used as woodland and for recreation.

Dominantly Loamy Soils of the Till Plains

In this group of associations are nearly level or gently sloping, somewhat poorly drained to very poorly drained soils on till plains. These soils formed mainly in loamy material. Limestone bedrock is at a moderate depth in places.

These associations are used mainly as woodland and for recreation. Some of the better drained minor soils in the associations are used for farming. The soils in this group generally are not suited to crops, because of wetness and the hazard of frost.

The two associations in this group make up about 15 percent of the survey area.

9. Nahma-Ensley-Cathro association

Nearly level, poorly drained, loamy soils and nearly level, very poorly drained organic soils

This association consists of soils on till plains.

This association occupies about 6 percent of the survey area. Nahma soils make up about 23 percent of the association, Ensley soils make up 22 percent, Cathro soils make up 13 percent, and minor soils make up the remaining 42 percent.

Nahma soils are nearly level, poorly drained loamy soils over limestone bedrock. They have a surface layer of black muck about 4 inches thick. The subsurface layer is black loam 5 inches thick. The subsoil is gray loam, brown fine sandy loam, and pale-brown loam. The underlying material is light greenish-gray loam and weathered limestone bedrock. Limestone bedrock is at a depth of 29 inches.

Ensley soils are nearly level and are poorly drained. They have a surface layer of black muck about 2 inches thick. The subsurface layer is black sandy loam 4 inches thick. The subsoil is grayish-brown fine sandy loam, light brownish-gray light sandy loam, reddish-brown light sandy clay loam, and reddish-brown sandy loam. The underlying material, at a depth of 30 inches, is reddish-brown sandy loam.

Cathro soils are nearly level and are very poorly drained. They have a surface layer of black muck about 4 inches thick. The subsurface layer is black mucky peat and black muck. Grayish-brown sandy loam is at a depth of 23 inches.

Minor soils in this association are in the Carbondale, Lupton, Rifle, Angelica, Charlevoix, Ensign, Longrie, Pickford, moderately wet, Summerville, Tacoosh, and Tawas series. Carbondale, Lupton, and Rifle soils are nearly level, very poorly drained, deep organic soils. Angelica soils are nearly level and are poorly drained. Charlevoix soils are nearly level or gently sloping, somewhat poorly drained, loamy soils. Ensign soils are nearly level or gently sloping, somewhat poorly drained, shallow, loamy soils. Longrie soils are nearly level or gently sloping, well drained or moderately well drained, moderately

deep, loamy soils. Pickford soils, moderately wet, are nearly level, somewhat poorly drained, clayey soils. Summerville soils are nearly level or gently sloping, well drained or moderately well drained, shallow, loamy soils. Tacoosh and Tawas soils are nearly level, very poorly drained organic soils that are 16 to 51 inches deep over loamy and sandy materials. The minor soils are in areas throughout the association.

The loamy and clayey soils in this association have medium to high fertility and moderate to high available water capacity. The organic soils have low fertility and very high available water capacity. The major limitations to the use and management of the soils of this association are wetness and hazard of frost on the somewhat poorly drained soils and the hazard of erosion on the moderately well drained or well drained soils. Shallow depth to bedrock is a limitation on the Ensign and Summerville soils.

Most areas of the major soils in this association are used as woodland. A few areas are used for hay and pasture. Some areas of the well-drained to somewhat poorly drained minor soils are used for hay, pasture, or small grain, but most areas are used as woodland. Many of the cleared areas in this association are idle or are reverting to brush. Woodpulp and posts are the major wood products. This association is heavily used by deer as winter yarding areas.

10. Charlevoix-Ensley-Angelica association

Nearly level to gently sloping, somewhat poorly drained and poorly drained, loamy soils

This association consists of soils on till plains.

This association occupies about 9 percent of the survey area. Charlevoix soils make up about 28 percent of the association, Ensley and Angelica soils make up 25 percent, and minor soils make up the remaining 47 percent.

Charlevoix soils are nearly level or gently sloping, somewhat poorly drained soils. They have a surface layer of very dark brown sandy loam about 2 inches thick. The subsurface layer is grayish-brown sandy loam about 5 inches thick. The subsoil is brown sandy loam and dark-brown loam. Brown sandy loam is at a depth of 29 inches.

Ensley soils are nearly level, poorly drained soils. They have a surface layer of black muck about 2 inches thick. The subsurface layer is black sandy loam 4 inches thick. The subsoil is grayish-brown fine sandy loam, light brownish-gray light sandy loam, reddish-brown light sandy clay loam, and reddish-brown sandy loam. The underlying material, at a depth of 30 inches, is reddish-brown sandy loam.

Angelica soils are poorly drained, nearly level soils. They have a surface layer of black muck about 2 inches thick. The subsurface layer is very dark gray loam 4 inches thick. The subsoil is grayish-brown sandy loam, dark-brown loam, and reddish-brown light sandy clay loam. Light-brown loam is at a depth of about 15 inches.

Minor soils in this association are in the Carbondale, Lupton, Rifle, Onaway, Trenary, Cathro, and Tacoosh series. Carbondale, Lupton, and Rifle soils are nearly level, very poorly drained, deep organic soils. Onaway and Trenary soils are nearly level to moderately steep, well drained or moderately well drained, loamy soils. Cathro and Tacoosh soils are nearly level, very poorly drained organic soils 16 to 51 inches thick over loamy material. Trenary soils are mainly in the northern part of Delta County, and Onaway soils are mainly in the southern part of Delta County. The other minor soils are in areas throughout the association. The minor soils form a drainage sequence with the major soils.

The major soils and the loamy minor soils have medium to high fertility and moderate to high available water capacity. The minor organic soils have low fertility and very high available water capacity. The major limitations to the use and management of the soils in this association are wetness and hazard of frost on the major soils and the poorly drained minor soils and the hazard of erosion on the moderately well drained or well drained upland soils.

The major soils in this association are used as woodland. A few areas have been cleared and are used mainly for pasture and hay. A small acreage of the Onaway and Trenary soils is used for potatoes, small grain, and hay or pasture. Nearly all of the acreage of the minor soils is used as woodland. Wood pulp and cedar posts are the major wood products. Sawlogs come mainly from the Onaway and Trenary parts of the association.

Dominantly Sandy and Organic Soils of the Lake Plains and Outwash Plains

In this group of associations are nearly level to very steep, well-drained to very poorly drained soils on lake plains and outwash plains. The soils formed mainly in sandy material and organic material.

All of the associations in this group are used as woodland and for recreation. The associations are generally poorly suited to crops because the soils are wet, low in fertility, or subject to a hazard of frost.

Four soil associations are in this group. They make up 31 percent of the survey area.

11. Dawson-Tawas-Rousseau association

Nearly level, very poorly drained organic soils and gently sloping to very steep, well drained and moderately well drained sandy soils

This association consists of nearly level organic soils interspersed with gently sloping to very steep dunes on lake plains.

This association occupies about 9 percent of the survey area. Dawson soils make up about 25 percent of this association, Tawas soils make up 20 percent, Rousseau soils make up 17 percent, and minor soils make up the remaining 38 percent.

Dawson soils are extremely acid, nearly level, and very poorly drained. The surface layer is dark reddish-brown peat 8 inches thick. The subsurface layer is dark reddish-brown muck. The underlying material begins at a depth of 38 inches and consists of a thin layer of very dark gray silt loam underlain by grayish-brown sand.

Tawas soils are nearly level and very poorly drained. The surface layer is very dark grayish-brown mucky peat 4 inches thick. Below this is black and very dark gray muck that is underlain by dark grayish-brown sand at a depth of 18 inches.

Rousseau soils are nearly level to very steep, well drained or moderately well drained soils. The surface layer is black fine sand 1 inch thick. The subsurface layer is pinkish-gray fine sand 7 inches thick. The subsoil is

dark reddish-brown, yellowish-red, and strong-brown fine sand. Reddish-yellow fine sand begins at a depth of 25 inches.

Minor soils in this association are in the Au Gres, Carbondale, Greenwood, Lupton, Rifle, Roscommon, and Rubicon series. Au Gres soils are nearly level or gently sloping, somewhat poorly drained, sandy soils. Carbondale, Greenwood, Lupton, and Rifle soils are nearly level, very poorly drained, deep organic soils. Roscommon soils are nearly level, poorly drained sandy soils. Rubicon soils are nearly level to very steep, well-drained, sandy soils. The minor soils are in areas throughout the association. All of the soils in this association have low fertility. Available water capacity is very high in the organic soils and very low to low in the sandy soils. The major limitations to the use and management of the soils in this association are wetness, acidity, and hazard of frost on the poorly drained and very poorly drained soils and low fertility, hazard of soil blowing, droughtiness, and steepness on the well drained or moderately well drained upland soils.

This association is used as woodland and for recreation. Pulp is the main wood product.

12. Kalkaska-Tawas-Carbondale association

Nearly level to very steep, well drained and moderately well drained, sandy soils and nearly level, very poorly drained organic soils

This association consists of areas of sandy soils on lake plains and outwash plains interspersed with areas of nearly level organic soils.

This association occupies about 7 percent of the survey area. Kalkaska soils make up about 40 percent of this association, Tawas soils make up 25 percent, Carbondale soils make up 15 percent, and minor soils make up the remaining 20 percent.

Kalkaska soils are nearly level to very steep and are well drained or moderately well drained. The surface layer typically is 2 inches of black, partly decomposed forest litter. The subsurface layer is pinkish-gray sand about 10 inches thick. The subsoil is dark reddish-brown to strong-brown sand. Light-brown sand is at a depth of about 27 inches.

Tawas soils are nearly level and very poorly drained. The surface layer is very dark grayish-brown mucky peat 4 inches thick. Below this is black and very dark gray muck that is underlain by dark grayish-brown sand at a depth of about 18 inches.

Carbondale soils are nearly level and very poorly drained. The surface layer is black mucky peat 4 inches thick. The second and third layers are black muck 28 inches thick. The fourth and fifth layers are dark reddish-brown and dark grayish-brown mucky peat that extends to a depth of 60 inches.

Minor soils in this association are in the Au Gres, Dawson, Greenwood, Kinross, Lupton, Roscommon, Rifle, and Rubicon series. The nearly level or gently sloping, somewhat poorly drained Au Gres soils and the nearly level, poorly drained Kinross and Roscommon soils are sandy soils that are transitional in drainage from the Kalkaska soils to the organic soils. Areas of the nearly level, very poorly drained Dawson, Greenwood, Lupton, and Rifle organic soils and the nearly level to very steep, well-drained, sandy Rubicon soils are in areas throughout the association.

All of the soils in this association have low fertility. Available water capacity is very high in the organic soils and very low in the sandy soils. The major limitations to the use and management of the soils of this association are wetness and hazard of frost on the poorly drained and very poorly drained soils and droughtiness and hazard of soil blowing on the well drained and moderately well drained soils.

All of this association is used as woodland and for recreation. Harvesting wood crops is the main enterprise.

13. Tawas-Carbondale-Roscommon association

Nearly level, very poorly drained organic soils and poorly drained, sandy soils

This association consists of soils on lake plains and outwash plains.

This association occupies about 9 percent of the survey area. Tawas soils make up about 30 percent of this association, Carbondale soils make up 25 percent, Roscommon soils make up 10 percent, and minor soils make up the remaining 35 percent.

Tawas soils are nearly level and very poorly drained. The surface layer is very dark grayish-brown mucky peat 4 inches thick. Below this is black and very dark gray muck that is underlain by dark grayish-brown sand at a depth of about 18 inches.

Carbondale soils are nearly level and very poorly drained. The surface layer is black mucky peat 4 inches thick. The second and third layers are black muck 28 inches thick. The fourth and fifth layers are dark reddish-brown and dark grayish-brown mucky peat that extends to a depth of 60 inches.

Roscommon soils are nearly level and poorly drained. The surface layer is black muck 4 inches thick. The next layer is dark-gray sand 2 inches thick. Beneath this is grayish-brown and dark grayish-brown sand that extends to a depth of 60 inches.

Minor soils in this association are in the Au Gres, Dawson, Greenwood, Kalkaska, Lupton, Onaway, Rifle, and Rubicon series. Au Gres soils are nearly level or gently sloping, somewhat poorly drained, sandy soils. Dawson, Greenwood, Lupton, and Rifle soils are nearly level, very poorly drained organic soils. Kalkaska soils are nearly level to very steep, well drained and moderately well drained, sandy soils. Onaway soils are nearly level to moderately steep, well drained and moderately well drained, loamy soils. Rubicon soils are nearly level to very steep, well-drained, sandy soils. Most areas of Onaway soils are in southwestern Delta County. The other minor soils are in areas throughout the association.

The soils in this association generally have low fertility, but the Onaway soils have high fertility. Available water capacity is very high in the organic soils, very low in the sandy soils, and high in the Onaway soils. The major limitations to the use and management of the soils in this association are wetness and hazard of frost on the poorly drained and very poorly drained soils and droughtiness and hazard of soil blowing on the well-drained sandy soils. The hazard of erosion is the major limitation on the Onaway soils.

Except for a few very small areas that are used for hay and pasture, all of this association is used as woodland and for recreation. Wood crop production is the main enterprise.

14. Roscommon-Tawas association

Nearly level, poorly drained, sandy soils and nearly level, very poorly drained organic soils

This association consists of soils on lake plains and outwash plains.

This soil association occupies about 6 percent of the survey area. Roscommon soils make up about 40 percent of the association, Tawas soils make up 20 percent, and minor soils make up the remaining 40 percent.

Roscommon soils are nearly level and poorly drained. The surface layer is black muck 4 inches thick. The next layer is dark-gray sand 2 inches thick. Beneath this is grayish-brown and dark grayish-brown sand that extends to a depth of 60 inches.

Tawas soils are nearly level and very poorly drained. The surface layer is very dark grayish-brown mucky peat 4 inches thick. Below this is black and very dark gray muck that is underlain by dark grayish-brown sand at a depth of about 18 inches.

Minor soils in this association are in the Au Gres, Carbondale, Lupton, Rifle, Kalkaska, Rousseau, and Rubicon series. Au Gres soils are nearly level or gently sloping, somewhat poorly drained, sandy soils. Carbondale, Lupton, and Rifle soils are nearly level, very poorly drained, deep organic soils. Kalkaska, Rousseau, and Rubicon soils are nearly level to very steep, well drained or moderately well drained, sandy soils. The minor soils are in areas throughout the association.

All of the soils in this association have low fertility. Available water capacity is very high in the organic soils and very low to low in the sandy soils. The major limitations to the use and management of the soils in this association are wetness, low fertility, and hazard of frost on the major soils and the poorly drained minor soils. Limitations on the well-drained minor soils are droughtiness, low fertility, and hazard of soil blowing.

This association is used as woodland and for recreation. Wood crop production is the main enterprise.

Descriptions of the Soils

This section describes the soil series and mapping units in the Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors given in the descriptions are those of a moist soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are of a soil series. Made land, for example, does not belong to a soil series but, nevertheless, is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, the woodland suitability group, and the recreation group in which the mapping unit has been placed. The page for the description of each capability unit and recreation group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*6*).[2]

Alluvial Land

Alluvial land (0 to 2 percent slopes) (Ad) is on nearly level, narrow flood plains along major streams. Most areas are 200 feet or less in width. Only a few areas are as much as 800 feet in width.

This land type includes somewhat poorly drained and poorly drained alluvial soil material that ranges from sand to loam. Most areas are poorly drained. Typically, the surface layer commonly is black muck 4 to 10 inches thick and is underlain by sand. In some places the soil material ranges from sandy loam to loam, but in many of these places sand is at a depth of 3 feet or more.

Included with Alluvial land in mapping are a few small areas of poorly drained mineral soils other than alluvial soils. Also included are a few areas of shallow organic soils.

Available water capacity is low or moderate, depending on texture. Runoff is very slow or ponded. Natural fertility is low or medium.

Most areas of this land type are used as woodland. A small acreage is used for pasture and hay. Wetness, the hazard of flooding, and lack of adequate drainage outlets are the major limitations to the use of Alluvial land for crops. Capability unit VIIwc–1 (L–4c); woodland suitability group not assigned; recreation group 10.

Alpena Series

The Alpena series consists of well-drained, nearly level to sloping soils that are mainly on low beach ridges along Lake Michigan, but a few scattered areas are on outwash plains. The soils formed dominantly in sandy and gravelly material.

In a representative profile the surface layer is very dark brown gravelly sandy loam 4 inches thick. The subsoil is very dark grayish-brown, friable, gravelly sandy loam 3

[2] Italic numbers in parentheses refer to Literature Cited, p. 157.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres				Total Percent
	Delta Co.	Alger Co.	Schoolcraft Co.	Total	
Alluvial land	8,207	594	1,484	10,285	0.9
Alpena gravelly sandy loam, 0 to 12 percent slopes	2,258			2,258	.2
Au Gres sand, 0 to 6 percent slopes	15,954	2,598	5,877	24,429	2.2
Au Gres loamy sand, gravelly subsoil variant, 0 to 4 percent slopes	1,049	9		1,058	.1
Blue Lake sand, 0 to 6 percent slopes	1,346	4,442	158	5,946	.5
Blue Lake sand, 6 to 18 percent slopes	245	8,186	990	9,421	.8
Blue Lake sand, 18 to 40 percent slopes	28	2,579		2,607	.2
Bohemian fine sandy loam, 0 to 6 percent slopes	869	90	62	1,021	.1
Bohemian fine sandy loam, 6 to 18 percent slopes	209	880	9	1,098	.1
Borrow pits	394	50	8	452	(1)
Bowers silt loam, 0 to 4 percent slopes	468			468	(1)
Brevort mucky loamy sand	2,443	58	288	2,789	.3
Brimley fine sandy loam, 0 to 4 percent slopes	3,570	86	104	3,760	.3
Bruce mucky fine sandy loam, coarse variant	3,026	49	1,048	4,123	.4
Burt mucky sandy loam, 2 to 12 percent slopes	598	312	315	1,225	.1
Carbondale, Lupton, and Rifle soils	62,258	14,106	11,938	88,302	7.8
Cathro muck	4,972	280		5,252	.5
Cathro and Tacoosh mucks	38,207	1,349		39,556	3.5
Charlevoix sandy loam, 0 to 4 percent slopes	57,743	102	113	57,958	5.1
Chatham fine sandy loam, 0 to 2 percent slopes		223		223	(1)
Chatham fine sandy loam, 2 to 6 percent slopes		2,281		2,281	.2
Chatham fine sandy loam, 6 to 18 percent slopes		538		538	(1)
Chippeny muck	5,404	3,095	30	8,529	.8
Croswell sand, 0 to 4 percent slopes	15,947			15,947	1.4
Dawson peat	466			466	(1)
Dawson and Greenwood peats	22,919	7,065	4,454	34,438	3.0+
Deerton sand, 0 to 6 percent slopes		1,012		1,012	.1
Deerton sand, 6 to 18 percent slopes		761		761	.1
Deerton-Burt complex, 0 to 6 percent slopes		330		330	(1)
Deford loamy fine sand	701		27	728	.1
Duel loamy sand, 0 to 6 percent slopes	2,798	61		2,859	.3
East Lake sand, 0 to 6 percent slopes	549	30	579	1,158	.1
East Lake loamy sand, acid variant, 0 to 6 percent slopes	27	898		925	.1
East Lake loamy sand, acid variant, 6 to 18 percent slopes		569		569	(1)
Eastport sand 0 to 6 percent slopes	2,826			2,826	.3
Eastport-Roscommon sands, 0 to 6 percent slopes	3,470	265		3,735	.3
Emmet sandy loam, 0 to 2 percent slopes	198			198	(1)
Emmet sandy loam, 2 to 6 percent slopes	3,330	198		3,528	.3
Emmet sandy loam, 6 to 12 percent slopes	687	22		709	.1
Ensign fine sandy loam, 0 to 3 percent slopes	4,806	544		5,350	.5
Ensley and Angelica soils	45,932	1,069	51	47,052	4.2
Fairport silt loam, 0 to 2 percent slopes	374			374	(1)
Fairport silt loam, 2 to 6 percent slopes	356			356	(1)
Gilchrist sand, 0 to 6 percent slopes	6	138	1,268	1,412	.1
Grayling sand, 0 to 6 percent slopes	6,169			6,169	.6
Grayling sand, 6 to 18 percent slopes	355			355	(1)
Greenwood peat	3,398	10	34	3,442	.3
Iosco sand, 0 to 6 percent slopes	3,600	71	97	3,768	.3
Kalkaska sand, 0 to 6 percent slopes	45,428	45,526	27,885	118,839	10.5
Kalkaska sand, 6 to 18 percent slopes	28,828	24,461	16,256	69,545	6.2
Kalkaska sand, 18 to 40 percent slopes	347	6,161	2,659	9,167	.8
Karlin sandy loam, 0 to 6 percent slopes	8,703	1,774	3,210	13,687	1.2
Karlin sandy loam, 6 to 18 percent slopes	4,632	443	1,924	6,999	.6
Kawbawgam sandy loam, 0 to 10 percent slopes		942	305	1,247	.1
Kawkawlin silt loam, 0 to 2 percent slopes	417	5		422	(1)
Keweenaw loamy sand, 0 to 6 percent slopes		1,427	122	1,549	.1
Keweenaw loamy sand, 6 to 18 percent slopes		1,024		1,024	.1
Kinross mucky sand	4,527	3,019	4,169	11,715	1.0
Kiva sandy loam, 0 to 6 percent slopes	9,044	671	96	9,811	.9
Kiva sandy loam, 6 to 20 percent slopes	761	58	83	902	.1
Lake beaches		153		153	(1)
Limestone rock land	15,610	28	397	16,035	1.4
Longrie sandy loam, 0 to 2 percent slopes	2,013	83		2,096	.2
Longrie sandy loam, 2 to 6 percent slopes	14,250	869	1,023	16,142	1.4
Longrie and Summerville sandy loams, 6 to 18 percent slopes	1,249	93		1,342	.1
Made land	1,252	136	39	1,427	.1
Mancelona loamy sand, 0 to 6 percent slopes	249		196	445	(1)
Mancelona loamy sand, 6 to 18 percent slopes	109		95	204	(1)

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Soil	Acres				Total Percent
	Delta Co.	Alger Co.	Schoolcraft Co.	Total	
Marsh	880	80	36	996	0.1
Melita sand, 0 to 6 percent slopes	569		87	656	.1
Menominee loamy sand, 0 to 6 percent slopes	2,533	23	1,149	3,705	.3
Menominee loamy sand, 6 to 18 percent slopes	167		254	421	(1)
Munising sandy loam, 0 to 6 percent slopes		14,305		14,305	1.3
Munising sandy loam, 6 to 18 percent slopes		5,282		5,282	.5
Munising sandy loam, 18 to 40 percent slopes		1,225		1,225	.1
Nahma loam	17,351	512	6	17,869	1.6
Nester silt loam, 0 to 2 percent slopes	217			217	(1)
Nester silt loam, 2 to 6 percent slopes	663			663	.1
Onaway fine sandy loam, 0 to 2 percent slopes	470			470	(1)
Onaway fine sandy loam, 2 to 6 percent slopes	27,238	39	267	27,544	2.4
Onaway fine sandy loam, 6 to 12 percent slopes	5,894		87	5,981	.5
Onaway fine sandy loam, 12 to 18 percent slopes	429			429	(1)
Onota-Chippeny complex, steep	6	733		739	.1
Onota-Deerton complex, 0 to 6 percent slopes		2,322		2,322	.2
Onota-Deerton complex, 6 to 18 percent slopes		1,272		1,272	.1
Otisco loamy sand, 0 to 6 percent slopes	2,324	55		2,379	.2
Pickford silt loam	734			734	.1
Pickford silt loam, moderately wet, 0 to 4 percent slopes	773			773	.1
Pickford complex, 0 to 4 percent slopes	1,132			1,132	.1
Roscommon mucky sand	32,455	3,943	7,590	43,988	3.9
Roscommon-Kalkaska sands, 0 to 6 percent slopes	2,960	322	348	3,630	.3
Rousseau fine sand, 0 to 6 percent slopes	1,147	21	122	1,290	.1
Rousseau fine sand, 6 to 18 percent slopes	130	80	78	288	(1)
Rousseau fine sand, hilly	11,938	38	711	12,687	1.1
Rubicon sand, 0 to 6 percent slopes	32,679	14,845	24,452	71,976	6.4
Rubicon sand, 6 to 18 percent slopes	14,808	4,969	9,635	29,412	2.6
Rubicon sand, 18 to 40 percent slopes	262	254		516	(1)
Ruse silt loam	3,545	567		4,112	.4
Saugatuck sand, 0 to 3 percent slopes	628		171	799	.1
Shelldrake sand, 0 to 8 percent slopes		1,074		1,074	.1
Skanee sandy loam, 0 to 6 percent slopes		701		701	.1
Steuben fine sandy loam, 0 to 6 percent slopes		3,571	1,040	4,611	.4
Steuben fine sandy loam, 6 to 18 percent slopes		4,249		4,249	.4
Summerville fine sandy loam, 0 to 4 percent slopes	16,974	258	419	17,651	1.6
Sundell fine sandy loam, 0 to 4 percent slopes	13,141	754		13,895	1.2
Sundell loamy fine sand, sandy variant, 0 to 4 percent slopes	753	115		868	.1
Tawas muck	54,905	9,612	21,716	86,233	7.6
Trenary fine sandy loam, 0 to 2 percent slopes	302	102		404	(1)
Trenary fine sandy loam, 2 to 6 percent slopes	31,936	2,266	3,309	37,511	3.3
Trenary fine sandy loam, 6 to 12 percent slopes	1,565	214		1,779	.2
Trenary fine sandy loam, 12 to 18 percent slopes	2,623	245	119	2,987	.3
Wainola fine sand, 0 to 4 percent slopes	1,712	9	221	1,942	.2
Wallace sand, 0 to 6 percent slopes	614	32	61	707	.1
Wallace sand, 6 to 18 percent slopes	1,417	115	58	1,590	.1
Wheatley mucky loamy sand	539	20		559	.1
Yalmer sand, 0 to 6 percent slopes	1,076	491		1,567	.1
Yalmer sand, 6 to 18 percent slopes	130	208		338	(1)
Total	755,200	216,746	159,329	1,131,275	100.0

[1] Less than 0.05 percent.

inches thick. The underlying material is brown very gravelly sand.

Alpena soils have very low available water capacity and low natural fertility. Permeability is rapid. Runoff is slow.

These soils are used as woodland and for recreation. They are too droughty for farming.

Representative profile of Alpena gravelly sandy loam, 0 to 12 percent slopes, in a wooded area, in the SW¼NE¼-NW¼ sec. 5, T. 39 N., R. 18 W., Delta County:

A1—0 to 4 inches, very dark brown (10YR 2/2) gravelly sandy loam; weak, medium, granular structure; very friable; 20 percent gravel; mildly alkaline; clear, smooth boundary.

B2—4 to 7 inches, very dark grayish-brown (10YR 3/2) gravelly sandy loam; weak, medium, granular structure; very friable; 25 percent gravel; slightly effervescent; mildly alkaline; gradual, smooth boundary.

IIC—7 to 60 inches, brown (10YR 5/3) very gravelly sand; single grained; loose; 45 percent gravel and cobblestones; strongly effervescent; moderately alkaline.

The solum ranges from 6 to 10 inches in thickness. It is 20 to 30 percent gravel and cobblestones. Reaction throughout the solum ranges from neutral to moderately alkaline. In a few places, all or part of the solum is slightly effervescent.

The A1 horizon has hue of 5YR to 10YR, value of 2, and chroma of 1 or 2. The B2 horizon is dark brown (10YR 4/3) or very dark grayish brown (10YR 3/2). It is gravelly sandy loam, gravelly loam, or gravelly loamy sand.

The IIC horizon has hue of 10YR, value of 5 or 6, and chroma of 3 or 4. It is very cobbly sand or very gravelly sand and is 35 to 50 percent limestone cobbles and gravel. In a few places, the IIC horizon contains strata of coarse sand, gravelly coarse sand, or gravel.

Alpena soils are near East Lake and Eastport soils. They have thinner, finer textured A and B horizons than East Lake soils. They have gravel-size particles throughout the profile that are lacking in Eastport soils.

Alpena gravelly sandy loam, 0 to 12 percent slopes (AlC).—Most areas of this soil are on low beach ridges along Lake Michigan. The ridges extend inland less than one-fourth mile. They are 3 to 10 feet high and about 30 to 50 feet wide. A few areas of this soil are several miles inland.

Included with this soil in mapping are some areas of soils, on ridges, that have a surface layer of black organic matter and sand 4 to 6 inches thick. The surface is stony in some areas. Swales between the ridges are moderately well drained or somewhat poorly drained in some areas. Bedrock is at a depth of 2 to 3 feet in a few swales. Where this Alpena soil is along Lake Michigan, the first two to four ridges along the shores are mainly limestone fragments of gravel and cobblestone size ½ inch to 4 inches in diameter. Also included are a few small areas of Eastport and East Lake soils.

Nearly all areas of this soil are used as woodland. This soil is also used as a source of fill for local roads and as sites for recreation. Some summer cottages are built on this soil. Care is needed in placing septic tanks in this soil, because of the coarse material in the substratum and shallowness to bedrock. Beaches in areas of this soil are extremely stony in most places, and their use is limited as sites for cottages and recreation.

The major limitations to use of this soil are droughtiness, stoniness, and low natural fertility. Capability unit VIs–2 (Ga); woodland suitability group 2f1; recreation group 12.

Angelica Series

The Angelica series consists of poorly drained, nearly level or depressional soils on till plains. These soils formed in loamy material.

In a representative profile the surface layer is very dark gray loam 4 inches thick and is overlain by a layer of black muck 2 inches thick. The subsoil is 11 inches thick. The upper part is mottled, grayish-brown, friable sandy loam 4 inches thick; the middle part is mottled, dark-brown, friable loam 4 inches thick; and the lower part is mottled, reddish-brown, firm light sandy clay loam 3 inches thick. The underlying material is mottled, light-brown loam.

Angelica soils have high available water capacity and high natural fertility. Permeability is moderately slow. Downward movement of water is restricted by the seasonal high water table. The water table is at a depth of 1 foot or less much of the time but drops to a depth of more than 3 feet in some areas during extended dry periods. Runoff is slow to ponded.

Most areas of these soils are used as woodland. These soils are better suited to grasses than to most other crops. Many areas lack good drainage outlets and are subject to frost hazard.

Angelica soils are mapped only in an undifferentiated group with Ensley soils in this survey area.

Representative profile of Angelica loam from an area of Ensley and Angelica soils, in a wooded area, 200 feet southeast of the NW corner sec. 29, T. 40 N., R. 20 W., Delta County:

O2—2 inches to 0, black (10YR 2/1) muck; weak, medium granular structure; very friable; slightly acid; abrupt, smooth boundary.

A1—0 to 4 inches, very dark gray (10YR 3/1) loam; weak, medium, subangular blocky structure; friable; slightly acid; abrupt, wavy boundary.

B21g—4 to 8 inches, grayish-brown (2.5Y 5/2) sandy loam; many, medium, distinct, dark-gray (5Y 4/1) mottles; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; neutral; abrupt, wavy boundary.

B22—8 to 12 inches, dark-brown (7.5YR 4/4) loam; common, fine, distinct, yellowish-red (5YR 5/6) mottles; weak, fine, subangular blocky structure; friable; less than 2 percent coarse fragments; neutral; clear, wavy boundary.

B23t—12 to 15 inches, reddish-brown (5YR 5/4) light sandy clay loam; common, fine, faint, yellowish-red (5YR 5/6) mottles; weak, medium, subangular blocky structure; firm; 2 percent coarse fragments; neutral; clear, wavy boundary.

C—15 to 60 inches, light-brown (7.5YR 6/4) loam; many, medium, distinct, light brownish-gray (2.5Y 6/2) and brownish-yellow (10YR 6/6) mottles; massive; friable; 3 percent coarse fragments; slightly effervescent; mildly alkaline.

The solum ranges from 14 to 30 inches in thickness but typically is about 20 inches thick. In a few places flaggy limestone is present throughout the profile. It represents less than 5 percent, by volume, of any horizon. Reaction of the solum ranges from slightly acid to neutral.

In many places a black (5YR 2/1 and 10YR 2/1) O2 horizon is present. In a few places a very dark gray (10YR 3/1) Ap horizon is present.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B21g horizon has hue of 7.5YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam, loam, or silt loam.

The B22 horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam, loam, or silt loam. The B23t horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 or 6. It is heavy loam, light sandy clay loam, or light clay loam.

The C horizon has hue of 5YR or 7.5YR, value of 5 to 7, and chroma of 3 or 4. It is sandy loam, loam, or silt loam, has faint or distinct mottles, and is as much as 5 percent coarse fragments. The C horizon is mildly alkaline or moderately alkaline in reaction.

Angelica soils are mapped only with Ensley soils and are near Nahma soils. They are similar to Ensley soils but have slightly more clay at a depth of 10 to 40 inches. They are more than 40 inches deep over bedrock, whereas Nahma soils are 20 to 40 inches deep over bedrock.

Au Gres Series

The Au Gres series consists of somewhat poorly drained, nearly level or gently sloping soils on outwash plains, lake plains, and till plains. These soils formed in sandy material.

In a representative profile the surface layer is very dark gray sand 3 inches thick. The subsurface layer is light brownish-gray sand 5 inches thick. The upper part of the subsoil is mottled, dark reddish-brown, friable sand 4 inches thick that is slightly cemented in places. The lower part of the subsoil is mottled, dark-brown, very friable

sand 15 inches thick. The underlying material is brown sand.

Au Gres soils have very low available water capacity and low natural fertility. Permeability is rapid. Depth to the seasonal high water table fluctuates between 1 and 2 feet. Runoff is slow.

Au Gres soils are used mainly as woodland.

Representative profile of Au Gres sand, 0 to 6 percent slopes, in a wooded area, in the NE¼SE¼SW¼ sec. 18, T. 42 N., R. 21 W., Delta County:

A1—0 to 3 inches, very dark gray (10YR 3/1) sand; weak, medium, granular structure; very friable; very strongly acid; abrupt, smooth boundary.

A2—3 to 8 inches, light brownish-gray (10YR 6/2) sand; very weak, medium, granular structure; very friable; very strongly acid; abrupt, irregular boundary.

B21hir—8 to 12 inches, dark reddish-brown (5YR 2/2) sand; common, medium, distinct, reddish-brown (5YR 4/4) mottles; very weak, medium, subangular blocky structure; friable; very strongly acid; abrupt, irregular boundary.

B22ir—12 to 27 inches, dark-brown (7.5YR 4/4) sand; many, fine, distinct, strong-brown (7.5YR 5/8) mottles; very weak, coarse, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

C—27 to 60 inches, brown (10YR 5/3) sand; single grained; loose; slightly acid.

The solum ranges from 20 to 30 inches in thickness. Reaction throughout the solum ranges from very strongly acid to medium acid. In a few places the A1 and A2 horizons are mixed and form a very dark gray (10YR 3/1) or a dark-gray (10YR 4/1) Ap horizon. The A1 horizon is very dark gray (10YR 3/1) or black (10YR 2/1). The A2 horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 1 or 2.

The B21hir horizon has hue of 5YR or 7.5YR, value of 2 to 4, and chroma of 2 to 4. It has weakly cemented chunks of ortstein in a few places. The B22ir horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 to 6. A B3 horizon, as much as 15 inches thick, is present in a few places.

The C horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 3 to 6. It ranges from medium acid to slightly acid in reaction.

Au Gres soils are near moderately well drained Croswell soils, well drained or moderately well drained Kalkaska soils, well-drained Rubicon soils, and poorly drained Roscommon soils. They have mottles in the B horizon that are lacking in Croswell, Kalkaska, and Rubicon soils. They have an overall brighter color in the B horizon than Roscommon soils.

Au Gres sand, 0 to 6 percent slopes (AuB).—This soil is on outwash plains, lake plains, and till plains. Slopes are dominantly 1 to 4 percent. The surface layer is loamy sand in some areas.

Included with this soil in mapping are small areas of nearly level, well drained or moderately well drained Kalkaska soils, well-drained Rubicon soils, or moderately well drained Croswell soils. Also included in small depressions or drainageways are areas of poorly drained Roscommon soils.

This soil is used mainly as woodland. It is not commonly used for crops. Drainage is needed if it is used for crops. Not all areas have adequate tile outlets. Tiles are difficult to install, because ditchbanks cave in and sand plugs the tile unless proper blinding is used.

The major limitations to the use of this soil for crops are seasonal wetness, droughtiness, low natural fertility, slight hazard of frost, and hazard of soil blowing. Capability unit IVwc–2 (5b); woodland suitability group 3s3; recreation group 8.

Au Gres Series, Gravelly Subsoil Variant

The Au Gres series, gravelly subsoil variant, consists of somewhat poorly drained, nearly level or gently sloping soils on outwash plains and river terraces. The soils formed in sandy materials 20 to 40 inches thick over gravelly and sandy material.

In a representative profile the surface layer is very dark grayish-brown loamy sand 9 inches thick. The subsurface layer is grayish-brown loamy sand 1 inch thick. The upper part of the subsoil is mottled, dark-brown, friable loamy sand 2 inches thick, and the lower part is mottled, dark yellowish-brown, friable loamy sand 8 inches thick. The underlying material is brown, stratified coarse sand and fine gravel 22 inches thick over brown sand that extends to a depth of 60 inches or more.

Au Gres soils, gravelly subsoil variant, have low available water capacity and low natural fertility. Permeability is rapid. Depth to the seasonal high water table fluctuates between 1 and 2 feet. Runoff is slow.

These soils are used for hay, pasture, and as woodland. They are a potential source of gravel.

Representative profile of Au Gres loamy sand, gravelly subsoil variant, 0 to 4 percent slopes, in a cultivated field, in the SW¼SE¼SE¼ sec. 24, T. 40 N., R. 23 W., Delta County:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—9 to 10 inches, grayish-brown (10YR 5/2) loamy sand; weak, medium, granular structure; friable; slightly acid; abrupt, broken boundary.

B21ir—10 to 12 inches, dark-brown (7.5YR 3/2) loamy sand; few, medium, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; slightly acid; abrupt, wavy boundary.

B22ir—12 to 20 inches, dark yellowish-brown (10YR 4/4) loamy sand; many, medium, distinct, strong-brown (7.5YR 5/6 and 7.5YR 5/8) mottles; weak, coarse, subangular blocky structure; friable; slightly acid; abrupt, smooth boundary.

IIC1 20 to 42 inches, brown (10YR 5/3) stratified coarse sand and fine gravel; single grained; loose; slightly effervescent; mildly alkaline; abrupt, smooth boundary.

IIC2—42 to 60 inches, brown (7.5YR 5/2) sand; single grained; loose; slightly effervescent; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness. Reaction throughout the solum ranges from medium acid to neutral.

In undisturbed areas the A1 horizon is black (10YR 2/1) to very dark gray (10YR 3/1) and is 2 to 3 inches thick. The Ap horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 5/2).

The B21ir horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 or 6. It is sand or loamy sand. A B3 horizon that has colors similar to those of the B21ir horizon is present in places. It is sand or loamy sand.

The IIC horizon has hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 2 to 4. It ranges from sand to gravel in texture and from neutral to moderately alkaline in reaction. The IIC horizon is commonly stratified.

Au Gres soils, gravelly subsoil variant, are near Wheatley soils and have the same drainage characteristics as Au Gres soils. They have an overall brighter color in the B horizon than Wheatley soils. They have a stratified C horizon, containing gravel, which is lacking in Au Gres soils.

Au Gres loamy sand, gravelly subsoil variant, 0 to 4 percent slopes (AvA).—This soil is on outwash plains and river terraces.

Included with this soil in mapping are a few areas of poorly drained Wheatley soils in small depressions. Also included in the area around Kipling are areas where the underlying material contains more cobblestones and the subsoil is thinner.

This soil is used for hay and pasture and as woodland. Drainage is needed for crops. Ditches remove enough water to grow hay and oats, but tiling is required to grow alfalfa and other crops. Tile is difficult to install, because the sandy and gravelly soil caves in readily in trenches. Sand clogs the tile unless adequate blinding is used. This soil is a potential source of gravel.

A seasonal high water table, droughtiness when drained, and low fertility are the major limitations to the use of this soil for crops. Capability unit IIIwc–5 (4b); woodland suitability group 3s3; recreation group 8.

Blue Lake Series

The Blue Lake series consists of well-drained, nearly level to steeply sloping soils on till plains and moraines. These soils formed dominantly in sandy material.

In a representative profile the surface layer is black sand 1 inch thick. The subsurface layer is reddish-gray sand 9 inches thick. The subsoil is 15 inches thick. The upper 10 inches is dark reddish-brown, very friable sand that contains a few chunks of weakly cemented ortstein; and the lower 5 inches is yellowish-red, very friable sand. Beneath this is 7 inches of brown loose sand and reddish-brown, friable fine sandy loam. The underlying material is light-brown sand that contains many reddish-brown loamy sand bands, ¼ to ½ inch thick, and extends to a depth of 60 inches or more.

Blue Lake soils have low available water capacity and low natural fertility. Permeability is rapid.

Only a small acreage of these soils is used for crops. Most of the areas are used as woodland. The soils are moderately well suited to northern hardwoods and pines.

Representative profile of Blue Lake sand, 0 to 6 percent slopes, in a wooded area, in the NE¼SE¼ sec. 10, T. 45 N., R. 20 W., Alger County:

A1—0 to 1 inch, black (5YR 2/1) sand; weak, fine, granular structure; very friable; strongly acid; abrupt, smooth boundary.

A2—1 to 10 inches, reddish-gray (5YR 5/2) sand; weak, fine, granular structure; very friable; very strongly acid; abrupt, irregular boundary.

B21hir—10 to 20 inches, dark reddish-brown (5YR 3/2) sand; very weak, fine, subangular blocky structure; very friable; few chunks of weakly cemented ortstein; strongly acid; abrupt, irregular boundary.

B22ir—20 to 25 inches, yellowish-red (5YR 4/8) sand; very weak, fine, subangular blocky structure; very friable; slightly acid; abrupt, smooth boundary.

A'&B'—25 to 32 inches, brown (7.5YR 5/4) sand (A') that is single grained and loose, and reddish-brown (2.5YR 4/4) fine sandy loam (B'); weak, medium, subangular blocky structure; friable; clay bridges connecting sand grains; medium acid; abrupt, smooth boundary.

C—32 to 60 inches, light-brown (7.5YR 6/4) sand; many reddish-brown (2.5YR 5/4) loamy sand bands, ¼ to ½ inch thick, in upper part; single grained; loose; medium acid.

The solum ranges from 30 inches to more than 70 inches in thickness. Reaction throughout the solum is strongly acid or medium acid.

The A1 horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1. The A2 horizon has hue of 5YR to 10YR, value of 5 to 7, chroma of 2.

The B21hir horizon has hue of 5YR, value of 2 or 3, and chroma of 2 or 3. It is sand or loamy sand. The B22ir horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 8. It is sand or loamy sand. The B21hir and B22ir horizons contain weakly cemented chunks of ortstein. A B3 horizon, as much as 10 inches thick, is present in a few places. It has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is sand or loamy sand.

The A' part of the A' & B' horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 to 4. It is sand or loamy sand. The B' part of the A' & B' horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is heavy loamy sand, sandy loam, fine sandy loam, or loam.

The C horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 4 to 6. In many places bands of loamy sand, ¼ to ½ inch thick, that have colors similar to those of the A' & B' horizon are in the C horizon. The C horizon ranges from medium acid to neutral in reaction.

Colors in the A' & B' and C horizons that have a hue redder than 7.5YR are outside the range defined for the Blue Lake series. This difference, however, does not affect the usefulness or behavior of the soils.

Blue Lake soils commonly are near Kalkaska, Karlin, Steuben, and Yalmer soils. They have an A' & B' horizon that is lacking in Kalkaska and Karlin soils. Blue Lake soils are coarser textured in the A horizon and in the upper part of the B horizon than Karlin and Steuben soils, and they lack the fragipan of Steuben soils. They have a sandy C horizon and lack a fragipan in the A' & B' horizon that is characteristic of Yalmer soils.

Blue Lake sand, 0 to 6 percent slopes (BlB).—This soil is on till plains, moraines, and lake plains. It has the profile described as representative of the series. Runoff is slow.

Included with this soil in mapping are a few small areas of Kalkaska, Karlin, and Steuben soils. Where this soil is near Steuben soils, the lower part of the subsoil is firm. The water table reaches a seasonal high of 3½ or 4 feet along swamp edges or in other lower positions in this mapping unit.

Most of this soil is used as woodland (fig. 5). Only a small acreage is used for crops. This soil has severe limitations to use for crops, because of droughtiness, low natural fertility, and the hazard of soil blowing. Capability unit IIIs–4 (4a); woodland suitability group 2s1; recreation group 1.

Blue Lake sand, 6 to 18 percent slopes (BlD).—This soil is on moraines and till plains. Runoff is slow.

Included with this soil in mapping are small areas of Kalkaska, Karlin, and Steuben soils. Where this soil is near Steuben soils, the lower part of the subsoil is firm. The surface layer and the subsoil are loamy sand in some areas.

Except for a very small acreage, nearly all this soil is used as woodland. Droughtiness, low natural fertility, steepness, and hazard of erosion are severe limitations to the use of this soil for crops. Capability unit IVe–9 (4a); woodland suitability group 2s1; recreation group 3.

Blue Lake sand, 18 to 40 percent slopes (BlE).—This soil is on moraines. Runoff is slow to medium, but the hazard of erosion is severe.

Included with this soil in mapping are small areas of Kalkaska, Karlin, and Munising soils. Where this soil is near Munising or Keweenaw soils, the lower part of the subsoil is firm.

This soil is used as woodland. Steepness, droughtiness, and hazard of erosion are limitations to the use and man-

Figure 5.—**Stands of hardwood trees in an area of Blue Lake sand. Most areas of Blue Lake sand are used as woodland; many areas support dense stands of second-growth maple trees.**

agement of this soil. Capability unit VIIe–2 (4a); woodland suitability group 2s2; recreation group 7.

Bohemian Series

The Bohemian series consists of well-drained, nearly level to steep soils on lake plains and dissected lake plains. These soils formed in loamy lacustrine material.

In a representative profile the surface layer is black organic material 2 inches thick. The subsurface layer is pinkish-gray fine sandy loam 5 inches thick. The upper 5 inches of the subsoil is reddish-brown, friable very fine sandy loam; the middle 7 inches is light-brown to brown fine sandy loam that is friable and has reddish-brown silt loam chunks in the lower 4 inches; and the lower 11 inches is reddish-brown, friable silt loam. The underlying material is reddish-brown loam 3 inches thick over pinkish-gray, stratified silt loam and very fine sand that extends to a depth of 60 inches or more.

Bohemian soils have high available water capacity and medium natural fertility. Permeability is moderate.

Bohemian soils are used for crops and as woodland.

Representative profile of Bohemian fine sandy loam, 6 to 18 percent slopes, in a wooded area, in the NW¼ SW¼ sec. 18, T. 46 N., R. 20 W., Alger County:

O1—2 inches to 0, black (5YR 2/1) organic litter; very strongly acid; abrupt, wavy boundary.

A2—0 to 5 inches, pinkish-gray (5YR 6/2) fine sandy loam; weak, fine, subangular blocky structure; friable; slightly acid; abrupt, wavy boundary.

B2ir—5 to 10 inches, reddish-brown (5YR 4/4) very fine sandy loam; weak, very fine subangular blocky structure; friable; slightly acid; abrupt, wavy boundary.

A'21—10 to 13 inches, light-brown (7.5YR 6/4) fine sandy loam; weak, very fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

A'22—13 to 17 inches, brown (7.5YR 5/4) fine sandy loam; weak, fine, subangular blocky structure; friable; common reddish-brown (5YR 5/3) silt loam B'2t remnants; strongly acid; clear, wavy boundary.

B'2t—17 to 28 inches, reddish-brown (2.5YR 4/4) silt loam; moderate, fine subangular blocky structure; friable; few thin clay films on faces of peds; strongly acid; abrupt, wavy boundary.

C1—28 to 31 inches, reddish-brown (5YR 5/3) loam; weak, fine, angular blocky structure; friable; slightly effervescent; mildly alkaline; abrupt, smooth boundary.

C2—31 to 60 inches, pinkish-gray (5YR 6/2) stratified silt loam and very fine sand; weak, medium platy structure; friable; slightly effervescent; mildly alkaline.

The solum ranges from 25 to 30 inches in thickness. Reaction throughout the solum is strongly acid to slightly acid.

A very dark gray (10YR 3/1) Ap horizon, 6 to 9 inches thick, is present in cultivated areas. A black (5YR 2/1 or 10YR 2/1) A1 horizon, 1 to 3 inches thick, is present in a few places. The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, with chroma of 2.

A dark reddish brown (5YR 3/3 to 3/4) Bhir horizon, 1 to 2 inches thick, is present in a few places. The B2ir horizon has hue of 5YR, value of 4, and chroma of 3 or 4. It is very fine sandy loam or fine sandy loam.

The A'2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 to 4. It is fine sandy loam to silt loam. Remnants of the B'2t horizon are in the lower part of the A'2 horizon in some places.

The B'2t horizon is reddish brown (2.5YR 4/4 to 5YR 4/4) and is commonly one class finer in texture than the overlying horizons. Thin clay flows are around peds and in pore spaces.

The C horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 2 to 4. It is highly variable and has strata and varves ranging from fine sand to silty clay. The C horizon generally is silt loam. The strata and varves of silty clay seldom exceed 3 inches in thickness. The coarser textured strata are less red in color than the finer textured strata.

Bohemian soils formed in material similar to that of Brimley soils, and they have a texture similar to that of Onaway and Trenary soils. They lack mottles in the upper part of the B horizon that are typical of Brimley soils. They are more stratified than Onaway and Trenary soils because they formed in lacustrine material instead of till.

Bohemian fine sandy loam, 0 to 6 percent slopes (BoB).—This soil is on lake plains. Runoff is slow. The hazard of erosion is slight.

Included with this soil in mapping are a few areas of somewhat poorly drained Brimley soils in depressions. Karlin and Rousseau soils are included in some areas of this mapping unit. Also included are some areas where the substratum is slightly acid or neutral and areas where the surface layer is silt loam.

Most of this soil is used as woodland. The few acres that are farmed are used for adapted crops.

The major limitations to the use of this soil are those that affect construction. The high silt content makes this soil unstable and subject to frost heaving. Capability unit IIe–3 (2.5a); woodland suitability group 2o1; recreation group 4.

Bohemian fine sandy loam, 6 to 18 percent slopes (BoD). This soil is on dissected lake plains. It has the profile described as representative of the series. Runoff is slow to medium, depending on the plant cover. The hazard of erosion is severe.

Included with this soil in mapping are a few areas where the surface layer is silt loam. In some narrow drainageways are areas of somewhat poorly drained Brimley soils. In some cultivated areas the upper part of the subsoil is exposed in spots as a result of moderate erosion. The substratum is slightly acid or neutral in reaction in parts of Alger County. Where this soil is mapped southwest of Munising, the subsoil and substratum are finer textured than those in the described profile. Also included are areas of Rousseau soils and less than 100 acres of Bohemian soils, in Alger County, that have slopes of 18 to 40 percent.

Most of this soil is used as woodland. Only a small acreage is used for crops. Hay, oats, and pasture are the main crops. Steepness and the hazard of erosion are severe limitations to the use of this soil for crops.

The high silt content of this soil makes it unstable for roads. Where inadequate fill has been used, frost heaving and seep areas are common on roads built on this soil. Capability unit IVe–4 (2.5a); woodland suitability group 2o1; recreation group 6.

Borrow Pits

Borrow pits (Bp) consists of areas where soil material has been excavated for building and engineering uses. These areas range from about 2 to 50 acres in size. Sand and gravel are commonly removed. The material in most areas of Borrow pits is sandy or gravelly, but it is loamy in some places.

Most Borrow pits are left to nature after the material is removed. Trees will grow if the proper species are planted.

The areas of Borrow pits vary in drainage, texture, stoniness, and reaction. Each area needs to be managed individually when used for planting purposes. A soil conservationist or forester can recommend the species most likely to grow in a given area. Capability unit VIIIs–3; woodland suitability group not assigned; recreation group not assigned.

Bowers Series

The Bowers series consists of somewhat poorly drained, nearly level or gently sloping soils on lake plains. The soils formed in stratified loamy lacustrine material.

In a representative profile the surface layer is very dark gray silt loam 7 inches thick. The next layer is mottled, grayish-brown silt loam 4 inches thick that has reddish-brown chunks of silty clay loam in the lower part. The subsoil is mottled, reddish-brown, firm silty clay loam 7 inches thick. The underlying material is stratified, mottled, reddish-brown silt and silt loam and reddish-brown silty clay loam and silty clay.

Bowers soils have high available water capacity and high natural fertility. Permeability is moderately slow. These soils are excessively wet in spring or after heavy rains, but with adequate drainage they are easy to work and keep in good tilth. Depth to the seasonal high water table fluctuates between 1 and 2 feet. Runoff is slow or very slow.

These soils are used for crops and pasture.

Representative profile of Bowers silt loam, 0 to 4 percent slopes, in a cultivated field, in the SE¼SW¼SW¼ sec. 16, T. 39 N., R. 18 W., Delta County:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam; moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A&B—7 to 11 inches, grayish-brown (10YR 5/2) silt loam (A2) containing common, fine, distinct, strong-brown (7.5YR 5/6) mottles; chunks of reddish-brown (5YR 5/4) silty clay loam (B2t) in the lower 3 inches; moderate, medium, subangular blocky structure; friable; slightly acid; clear, irregular boundary.

B2t—11 to 18 inches, reddish-brown (2.5YR 4/4) silty clay loam; few, fine, dark-gray (5YR 4/1) mottles; few tongues of grayish-brown (10YR 5/2) A2 material in upper 3 inches; moderate, coarse, angular blocky structure; firm, common, thin, clay films on faces of peds; neutral; clear, wavy boundary.

C—18 to 60 inches, stratified reddish-brown (5YR 5/3) silt and silt loam; common, fine, distinct, yellowish-red (5YR 5/6) mottles; moderate, medium, platy structure; friable; and reddish-brown (2.5YR 5/4 and 4/4) silty clay loam and silty clay; moderate, medium, angular blocky structure; firm; strata throughout are ½ inch to 12 inches thick; slightly effervescent; mildly alkaline.

The solum ranges from 15 to 24 inches in thickness. Reaction throughout the solum is slightly acid to neutral.

Undisturbed areas have a black (10YR 2/1) A1 horizon 2 to 5 inches thick. The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A part of the A&B horizon is grayish brown (10YR 5/2) or pale brown (10YR 6/3). The A2 horizon tongues into the B2t horizon.

The B2t horizon has hue of 2.5YR to 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam or silty clay loam.

The C horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 3 or 4. The finer textured strata are redder than the coarser strata. The C horizon ranges from silt to clay, and individual strata range from ½ inch to 12 inches in thickness.

Bowers soils in this survey area have a thinner solum and redder colors than are defined as within the range for the series. These differences, however, do not affect the usefulness or behavior of the soils.

Bowers soils have drainage characteristics similar to those of Brimley and Kawkawlin soils. They lack the dark-brown B horizon of Brimley soils and have more clay at a depth of 10 to 40 inches than Brimley soils. They formed in stratified lacustrine material instead of the glacial till that is characteristic of Kawkawlin soils.

Bowers silt loam, 0 to 4 percent slopes (BrA).—This soil is on lake plains. Included in mapping are a few areas of Brimley soils.

Most of the acreage of this soil has been cleared and is used for oats, hay, or pasture. A small wooded area supports stands of aspen and balsam fir.

If adequately drained and fertilized, this soil is suited to adapted crops.

Wetness is the major limitation to the use of this soil. Ditches are needed to remove surface water and to provide adequate drainage for hay and pasture. Tiling is needed if row crops are to be grown on this soil. Capability unit IIwc–2 (1.5b); woodland suitability group 2o5; recreation group 9.

Brevort Series

The Brevort series consists of poorly drained, nearly level or depressional soils on lake plains, till plains, and outwash plains. The soils formed in 20 to 40 inches of sandy material overlying loamy glacial material.

In a representative profile the surface layer is black muck 8 inches thick over 2 inches of dark-gray loamy sand. The underlying material extends to a depth of 60 inches or more. The upper part is mottled, grayish-brown, loose loamy sand 9 inches thick; the middle part is mottled, brown, very friable loamy sand 11 inches thick; and the lower part is mottled, light yellowish-brown loam.

Brevort soils have low available water capacity in the sandy layers and moderate available water capacity in the loamy layers. Natural fertility is low. Permeability is rapid in the sandy part of the soils and moderately slow in the underlying material. These soils receive runoff from adjacent higher soils. This additional water contributes to soil wetness. In undrained areas the seasonal high water table is at a depth of 12 inches in spring. Runoff is very slow or ponded.

These soils are used as woodland.

Representative profile of Brevort mucky loamy sand, in a wooded area, in the NE¼SW¼SE¼ sec. 23, T. 39 N., R. 24 W., Delta County:

O2—8 inches to 0, black (10YR 2/1) muck; weak, medium, granular structure; friable; slightly acid; clear, wavy boundary.

A1—0 to 2 inches, very dark gray (10YR 3/1) loamy sand; weak, medium, granular structure; very friable; slightly acid; clear, smooth boundary.

C1g—2 to 11 inches, grayish-brown (10YR 5/2) loamy sand common, medium, faint, pale-brown (10YR 6/3) mottles; single grained; loose; slightly acid; gradual, smooth boundary.

C2—11 to 22 inches, brown (7.5YR 5/4) loamy sand; common, coarse, faint, yellowish-brown (10YR 5/4) mottles; weak, fine, subangular blocky structure; very friable; neutral; abrupt, smooth boundary.

IIC3—22 to 60 inches, light yellowish-brown (10YR 6/4) loam; many, medium, faint, brownish-yellow (10YR 6/6) mottles; many partly decomposed dolomite fragments; 3 percent coarse fragments; slightly effervescent; mildly alkaline.

Depth to the IIC3 horizon ranges from 20 to 40 inches but is commonly 20 to 30 inches. Reaction of the sandy layers ranges from medium acid to neutral.

The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1). Texture resulting from mixing the O2 and A1 horizons is mucky loamy sand.

The C1g horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2. It is sand or loamy sand. The C2 horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 2 to 4. It is sand or loamy sand.

The IIC3 horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 or 4. It ranges from light loam to heavy silt loam. Limestone cobbles and fragments are common in the IIC3 horizon in places.

Brevort soils in the survey area have an O2 horizon as much as 12 inches in thickness, a lighter colored A1 horizon, and brighter colors in the upper part of the C horizon than are defined as within the range for the series. These differences, however, do not alter the usefulness or behavior of the soils.

Brevort soils have drainage characteristics similar to those of Roscommon and Wheatley soils. They have a loamy IIC horizon that is lacking in the Roscommon soils. They have a loamy IIC horizon instead of a gravelly sand IIC horizon that is characteristic of Wheatley soils.

Brevort mucky loamy sand (0 to 2 percent slopes) (Bs). This soil is on till plains, outwash plains, and lake plains.

Included with this soil in mapping are a few small areas of Roscommon and Tawas soils, some areas where the sandy layers are only 16 to 20 inches thick, and a few areas where the surface layer is sand. Also included, where this soil is associated with Pickford and Bruce soils, coarse variant, are areas where the underlying material is silt loam or silty clay lacustrine material.

This soil is used mainly as woodland. Very little of the acreage is used for crops. Drainage is needed for cultivated crops. Not all areas have adequate tile outlets. Tile is difficult to install, because of trench caving. Ditching removes enough water to grow oats and hay.

Poor natural drainage, low natural fertility, and frost hazard are the major limitations to the use of this soil for crops. Capability unit IIIwc–10 (4/2c); woodland suitability group 5w1; recreation group 10.

Brimley Series

The Brimley series consists of somewhat poorly drained, nearly level to gently sloping soils on lake plains. These soils formed in stratified loamy lacustrine deposits.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam 6 inches thick. The subsurface layer is reddish-gray silt loam 2 inches thick. The subsoil is 14 inches thick. The upper part is mottled, dark-brown, friable very fine sandy loam 7 inches thick; the middle part is reddish-gray, friable silt loam 2 inches thick; and the lower part is reddish-brown, friable, heavy silt loam 5 inches thick. The underlying material, which

extends to a depth of 60 inches or more, is reddish-brown, stratified silt, silt loam, and very fine sand.

Brimley soils have high available water capacity and medium natural fertility. Permeability is moderate. The water table fluctuates between depths of about 1 and 4 feet. These soils are excessively wet in spring, but with adequate drainage the soils are easy to work and keep in good tilth. Runoff is slow, and water ponds in depressions for short periods.

Brimley soils are used mainly as woodland. Small areas have been cleared and are used for hay and pasture.

Representative profile of Brimley fine sandy loam, 0 to 4 percent slopes, in a cultivated field, in the NW¼NW¼ SW¼ sec. 31, T. 41 N., R. 18 W., Delta County:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; moderate, fine, granular structure; friable; medium acid; abrupt, smooth boundary.

A2—6 to 8 inches, reddish-gray (5YR 5/2) silt loam; moderate, fine, granular structure; friable; medium acid; abrupt, wavy boundary.

B2ir—8 to 15 inches, dark-brown (7.5YR 4/4) very fine sandy loam; many, fine, distinct, yellowish-red (5YR 5/6) mottles; moderate, fine, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

A'2—15 to 17 inches, reddish-gray (5YR 5/2) silt loam; common, fine, faint, reddish-brown (5YR 5/4) mottles; weak, medium, platy structure; friable; medium acid; clear, wavy boundary.

B'2t—17 to 22 inches, reddish-brown (5YR 4/3) heavy silt loam; moderate, fine, angular blocky structure; friable; thin clay films on faces of peds; slightly acid; abrupt, wavy boundary.

C—22 to 60 inches, reddish-brown (5YR 5/4 to 2.5YR 4/4) stratified and varved silt, silt loam, and very fine sand; massive structure parting to weak, medium, angular blocky; friable; slightly effervescent; mildly alkaline; abrupt, smooth boundaries between layers and varves.

The solum ranges from 20 to 30 inches in thickness. Reaction throughout the solum ranges from medium acid to neutral.

In undisturbed areas there is a black (10YR 2/1) A1 horizon 1 to 2 inches thick. The A2 horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 1 or 2.

In a few places there is a dark reddish-brown (5YR 3/3 to 3/4) B1hir horizon, 1 to 2 inches thick, above the B2ir horizon. The B2ir horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6.

The A'2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 to 4. The B'2t horizon has hue of 2.5YR to 5YR, value of 4 or 5, and chroma of 3 or 4. It ranges from silt loam to light silty clay loam.

The C horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 2 to 4. The finer textured strata are redder in color than the coarser textured strata. The C horizon is highly variable; it has strata and varves ranging from fine sand to silty clay, but it centers on silt loam. The thickness of the various strata and varves ranges from ¼ inch to 12 inches. Reaction of the C horizon is mildly alkaline or moderately alkaline.

Brimley soils have drainage characteristics similar to those of Bowers and Charlevoix soils and Pickford soils, moderately wet. They have less clay at a depth of 10 to 40 inches than Bowers soils and Pickford soils, moderately wet. They formed in stratified lacustrine sediment, whereas Charlevoix soils formed in till.

Brimley fine sandy loam, 0 to 4 percent slopes (BtA).—This soil is on lake plains.

Included with this soil in mapping are a few areas of poorly drained Bruce soils, coarse variant, in depressions and drainageways and areas of Wainola and Charlevoix soils. Also included, where this Brimley soil is near Kalkaska soils, are areas of soils that have a surface layer of sand.

Most of this soil is used as woodland. A small acreage is cleared and is used for hay and pasture. Some areas are idle. Drainage is needed for cultivated crops. Not all areas have adequate tile outlets.

Seasonal wetness and a slight hazard of frost are the major limitations to the use of this soil. Capability unit IIwc-6 (2.5b); woodland suitability group 2o5; recreation group 9.

Bruce Series, Coarse Variant

The Bruce series, coarse variant, consists of poorly drained, nearly level or depressional soils on lake plains. These soils formed in dominantly sandy lacustrine material that has scattered loamy lenses or bands in the underlying material.

In a representative profile the surface layer is black muck 5 inches thick over 2 inches of very dark gray fine sandy loam. The subsoil is mottled, grayish-brown, friable very fine sandy loam in the upper 3 inches and is mottled, pinkish-gray, friable loamy very fine sand in the lower 5 inches. The underlying material is mottled, light reddish-brown loamy very fine sand that has scattered lenses of loamy sand and silt loam.

Bruce soils, coarse variant, have high available water capacity and medium natural fertility. Permeability is moderate, but downward movement of water is restricted by the seasonal high water table, which is within a depth of 12 inches for extended periods. The water table drops to a depth of 2 or 3 feet in some areas during dry summers. Runoff is very slow or ponded.

Nearly all of the acreage of these soils is used as woodland. Only a small acreage is cleared and is used for pasture.

Representative profile of Bruce mucky fine sandy loam, coarse variant, in a wooded area, in the NE¼NW¼SE¼ SW¼ sec. 35, T. 41 N., R. 21 W., Delta County:

O2—5 inches to 0, black (5YR 2/1) muck; moderate, medium, granular structure; friable; slightly acid; clear, smooth boundary.

A1—0 to 2 inches, very dark gray (5Y 3/1) fine sandy loam; weak, medium, granular structure; friable; slightly acid; clear, wavy boundary.

B21g—2 to 5 inches, grayish-brown (2.5Y 5/2) very fine sandy loam; common, fine, faint, light olive-brown (2.5Y 5/4 or 5/6) mottles; massive structure parting to weak, thick, platy; friable; neutral; clear, wavy boundary.

B22g—5 to 10 inches, pinkish-gray (7.5YR 6/2) loamy very fine sand; common, medium, faint, brownish-yellow (10YR 6/6) mottles; massive structure parting to weak, thick, platy; friable; neutral; gradual, smooth boundary.

C—10 to 60 inches, light reddish-brown (5YR 6/3) loamy very fine sand that has occasional thin lenses of loamy sand and silt loam; many, medium, prominent, reddish-yellow (5YR 6/8) mottles; massive; friable; slightly effervescent; moderately alkaline.

The solum ranges from 10 to 20 inches in thickness. Reaction throughout is slightly acid to neutral.

The O2 horizon is black (5YR 2/1 or 10YR 2/1). The A1 horizon is black (5YR 2/1 to 5Y 2/1). The Ap horizon is very dark grayish brown (10YR 3/2). The A1 horizon is thinnest where the O2 horizon is thickest. The O2 and A1 horizons, if mixed, are mucky fine sandy loam.

The B21g horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. The B22g horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. The B horizon is loamy very fine sand or very fine sandy loam.

The C horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 or 4. Its color and texture differ within short horizontal distances. It ranges from very fine sand to silt and has thin strata of clay, silty clay, silt loam, and sandy loam. It ranges from neutral to moderately alkaline in reaction.

Bruce soils, coarse variant, in most places are near Brimley, Deford, Ensley, and Angelica soils. They lack the dark-brown Bir horizon that is characteristic of Brimley soils. They are finer textured throughout the profile than Deford soils. They formed in stratified lacustrine material, whereas Ensley and Angelica soils formed in glacial till.

Bruce mucky fine sandy loam, coarse variant (0 to 2 percent slopes) (Bu).—This nearly level or depressional soil is on lake plains.

Included with this soil in mapping are slightly higher areas of somewhat poorly drained Brimley soils and a few, low, sandy ridges in some of the larger wooded areas. Also included are some areas where the underlying material is more acid than that of this Bruce soil. As much as 12 inches of muck is on the surface in places.

Except for a small acreage that is used for pasture, nearly all this soil is used as woodland. Drainage is needed for cultivated crops. Not all areas have adequate tile outlets. Tile is difficult to install, because trenches cave in and the soil material flows. Ditches can remove enough water so that hay and pasture can be grown.

Poor natural drainage and hazard of frost are the major limitations to the use of this soil for crops. Capability unit IIwc–6 (3c); woodland suitability group 4w1; recreation group 10.

Burt Series

The Burt series consists of poorly drained, nearly level to sloping soils on sandstone benches. These soils formed in 10 to 20 inches of sandy material overlying sandstone bedrock.

In a representative profile the surface layer is very dark gray mucky sandy loam 5 inches thick. The underlying material is mottled, grayish-brown, loose sand in the upper 6 inches; mottled, light brownish-gray, loose sand in the middle 6 inches; and gray and light brownish-gray, highly weathered sandstone bedrock in the lower 9 inches. At a depth of 26 inches the bedrock is firm.

Burt soils have low available water capacity and low natural fertility. Permeability is rapid, but downward movement of water is impeded by the bedrock. The seasonal high water table is within a depth of 12 inches for much of the year. Some areas are saturated all year as a result of seepage from higher elevations. Runoff is very slow.

Burt soils are used as woodland.

Representative profile of Burt mucky sandy loam, 2 to 12 percent slopes, in a wooded area, in the SE¼NW¼ sec. 22, T. 47 N., R. 20 W., Alger County:

A1—0 to 5 inches, very dark gray (10YR 3/1) mucky sandy loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

C1g—5 to 11 inches, grayish-brown (2.5Y 5/2) sand; common, medium, faint, dark-gray (5Y 4/1) mottles; single grained; loose; slightly acid; gradual, smooth boundary.

C2g—11 to 17 inches, light brownish-gray (10YR 6/2) sand; few, medium, faint, light yellowish-brown (10YR 6/4) mottles; single grained; loose; slightly acid; gradual, smooth boundary.

IIC3—17 to 26 inches, gray (5Y 5/1) and light brownish-gray (2.5Y 6/2) highly weathered, soft sandstone; slightly acid; gradual, smooth boundary.

IIR—26 inches, gray (5Y 6/1), light brownish-gray (2.5Y 6/2), and yellowish-brown (10YR 5/4) sandstone; firm to very firm; can be cut with sharp auger or pick, but becomes harder with increasing depth.

Depth to bedrock ranges from 10 to 20 inches, but it is dominantly 15 to 18 inches. Reaction throughout the solum ranges from very strongly acid to slightly acid. As much as 6 inches of black (5YR 2/1) muck is on the surface in places.

The A1 horizon is black (5YR 2/1 or 10YR 2/1) or very dark gray (10YR 3/1 and N 3/0). The C1g horizon has hue of 10YR to 5Y, value of 5 to 7, and chroma of 1 or 2. In some places this is the only horizon present between the 02 or A1 horizon and the IIR horizon.

The C2g horizon is light gray (10YR 7/1 and 7/2), light brownish gray (10YR 6/2), brown (10YR 5/3), or yellowish brown (10YR 5/4). Mottling is most commonly faint in the C1g horizon. In the lower part of some horizons, distinct mottles are present that have hue of 10YR to 5YR, value of 3 to 6, and chroma of 4 to 8. The most distinct mottles are in lenses of finer material. The C1g and C2g horizons are sand or loamy sand that have scattered lenses or strata of sandy loam in places. Large amounts of sandstone slabs are throughout the profile in some areas.

Burt soils in the survey area have a paralithic contact rather than a lithic contact and have a coarser texture throughout the profile than is defined as within the range for the series. This difference, however, does not affect the usefulness or behavior of the soils.

Burt soils are near Kawbawgam soils. They are shallower and coarser textured below the B horizon than Kawbawgam soils. They lack the brown B horizon that is characteristic of Kawbawgam soils.

Burt mucky sandy loam, 2 to 12 percent slopes (BwC).—This soil is on seepy sandstone benches.

Included with this soil in mapping are some areas of soils that have a browner subsoil and a thicker sand layer than this Burt soil; also, west of Au Train the underlying bedrock is redder and harder. Also included are a few areas of soils that have slopes of less than 2 percent.

This soil is used as woodland.

Shallowness, wetness, and hazard of frost are the major limitations to the use and management of this soil. Capability unit VIIwc–2 (Rbc); woodland suitability group 4w1; recreation group 10.

Carbondale Series

The Carbondale series consists of very poorly drained, nearly level or depressional, deep organic soils on till plains, outwash plains, and lake plains. The soils formed in moderately well decomposed herbaceous and woody material.

In a representative profile the surface layer is black mucky peat (hemic material) 4 inches thick. The next two layers are black muck (sapric material) 28 inches thick. The next layer is dark reddish-brown mucky peat (hemic material) 20 inches thick. The lower layer, at a depth of 52 inches, is dark grayish-brown mucky peat (hemic material).

Carbondale soils have very high available water capacity and low natural fertility. Permeability is rapid. The seasonal high water table is at the surface most of the year but drops to a depth of 24 to 30 inches in some areas during extended dry periods. Runoff is very slow or ponded.

These soils are not used for crops, because of wetness and the severe hazard of frost. They are used as woodland and for wildlife habitat.

Representative profile of Carbondale mucky peat, from an area of Carbondale, Lupton, and Rifle soils, in a wooded area, in the NE¼NE¼NE¼NE¼ sec. 6, T. 41 N., R. 21 W., Delta County:

Oe1—0 to 4 inches, black (5YR 2/1, broken face and rubbed) hemic material, dark reddish brown (5YR 2/2) pressed about 40 percent fiber, 15 percent rubbed; weak, coarse, granular structure; nonsticky; fiber is herbaceous; neutral; clear, smooth boundary.

Oa1—4 to 10 inches, black (5YR 2/1, broken face and rubbed) sapric material, dark reddish brown (5YR 2/2) pressed; about 40 percent fiber, 10 percent rubbed; massive; nonsticky; fibers are woody; neutral; gradual, smooth boundary.

Oa2—10 to 32 inches, black (5YR 2/1, broken face, rubbed and pressed) sapric material, about 70 percent fiber, less than 10 percent rubbed; massive; nonsticky; fibers are woody; neutral; gradual, smooth boundary.

Oe2—32 to 52 inches, dark reddish-brown (5YR 3/2, broken face, rubbed and pressed) hemic material, about 60 percent fiber, 20 percent rubbed; massive; nonsticky; fibers are woody; neutral; gradual, smooth boundary.

Oe3—52 to 60 inches, dark grayish-brown (10YR 4/2, broken face and pressed) hemic material, very dark grayish brown (10YR 3/2) rubbed; about 80 percent fiber, 15 percent rubbed; massive; nonsticky; fibers are herbaceous; mildly alkaline.

The organic material is more than 51 inches in thickness. Reaction throughout the organic material ranges from medium acid to mildly alkaline. The surface tier is hemic material or sapric material, or both. The subsurface tier is sapric material. The bottom tier is dominantly hemic material or all hemic material. Hemic material makes up more than one-third of the subsurface and bottom tiers. Fibers are herbaceous or woody. Woody fragments as large as several inches in diameter are present in many areas. The organic material has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 4. Sapric materials normally have chroma of 1 or 2.

Carbondale soils are near Cathro, Greenwood, Lupton, Rifle, Tacoosh, and Tawas soils. They have more sapric material in the subsurface layer than Rifle soils and less sapric material in the bottom layer than Lupton soils. They are less acid than Greenwood soils and have thicker organic layers than Cathro, Tacoosh, and Tawas soils.

Carbondale, Lupton, and Rifle soils (0 to 2 percent slopes) (Cb).—The soils in this mapping unit are in depressions on till plains, outwash plains, and lake plains. These soils differ mainly in their degree of decomposition. Lupton soils are the most decomposed, Rifle soils the least decomposed, and Carbondale soils are in between. Carbondale soils make up the greater part of most areas. In the southern and western parts of Delta County, Lupton soils make up a greater percentage of the mapped areas. Rifle soils make up a small percentage of all mapped areas. The surface layer ranges from muck to peat.

Included with these soils in mapping is a small acreage of shallow organic soils, including Tacoosh, Cathro, and Tawas soils, which are near the edges of the mapped areas. Also included are some small areas where slopes are as much as 8 percent. These areas occur on sloping bedrock benches where continuous seeping of water has resulted in an organic matter buildup more than 51 inches thick.

These soils are used as woodland. They have severe limitations for farming, because of wetness and the hazard of frost. The soils provide food and cover for a variety of wildlife. Deer use these soils as yarding areas during winter. Storage of water is an important function of these soils. Most of the larger areas are directly connected to the surface drainage system and have streamflow through them. Capability unit VIIwc–15 (Mc); woodland suitability group 5w2; recreation group 11.

Cathro Series

The Cathro series consists of very poorly drained, nearly level or depressional organic soils on till plains. These soils formed in 16 to 51 inches of dominantly herbaceous organic material over loamy material.

In a representative profile the surface layer is black muck (sapric material) 4 inches thick. The next layer is black mucky peat (hemic material) 7 inches thick. The next layer is black muck (sapric material) 12 inches thick. The underlying material, at a depth of 23 inches, is mottled, grayish-brown sandy loam.

Cathro soils have very high available water capacity and low natural fertility. Permeability is rapid in the upper part of these soils and moderately slow in the lower part. These soils commonly have a seasonal high water table at the surface, but the water table drops to a depth of about 24 inches in some areas during extended dry periods. Runoff is very slow or ponded.

These soils are not used for crops, because of wetness and the hazard of frost. They are used as woodland.

Representative profile of Cathro muck, from an area of Cathro and Tacoosh mucks, in a wooded area, in the SW¼NW¼SW¼ sec. 23, T. 40 N., R. 21 W., Delta County:

Oa1—0 to 4 inches, black (5YR 2/1, broken face, rubbed and pressed) sapric material; about 40 percent fiber, 10 percent rubbed; weak, fine, granular structure; nonsticky; about 60 percent herbaceous fibers and 40 percent woody fiber; neutral; clear, wavy boundary.

Oe—4 to 11 inches, black (5YR 2/1, broken face and rubbed) hemic material, dark reddish brown (5YR 2/2) pressed; about 35 percent fiber, 12 percent rubbed; weak, medium, granular structure; nonsticky; about 60 percent woody fibers and 40 percent herbaceous fibers; neutral; clear, smooth boundary.

Oa2—11 to 23 inches, black (5YR 2/1, broken face, rubbed and pressed) sapric material; about 40 percent fiber, less than 10 percent rubbed; massive; nonsticky; about 60 percent herbaceous fibers and 40 percent woody fibers; neutral; abrupt, smooth boundary.

IIC—23 to 60 inches, grayish-brown (2.5Y 5/2) sandy loam; common, coarse, distinct, reddish-brown (5YR 5/3) and brown (10YR 5/3) mottles; massive; slightly sticky; slightly effervescent; mildly alkaline.

The organic layers range from 16 to 51 inches in thickness, but the dominant thickness is 20 to 30 inches. Reaction ranges from slightly acid to mildly alkaline.

The surface tier of the profile is hemic material or sapric material. The subsurface tier is dominantly sapric material. Fibers are mainly herbaceous. Some woody fragments are normally present. The organic material has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2.

The IIC horizon has hue of 5YR to 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam, loam, or light clay loam. Reaction is neutral to moderately alkaline.

Cathro soils are near Carbondale, Lupton, Rifle, Chippeny, Tacoosh, and Tawas soils. They have thinner organic layers than Carbondale, Lupton, and Rifle soils. They lack the limestone underlying material that is characteristic of Chippeny soils. They contain more sapric material than Tacoosh soils, and they have finer textured underlying material than Tawas soils.

Cathro muck (0 to 2 percent slopes) (Ch).—This nearly level or depressional soil is on till plains.

Included with this soil in mapping are a few areas of poorly drained Angelica and Ensley soils and areas of Tacoosh and Chippeny soils. Also included are areas of soils where limestone bedrock is at a depth of 4 feet or more.

This soil is used as woodland.

Major limitations to the use of this soil are wetness and hazard of frost. Capability unit VIIwc–10 (M/3c); woodland suitability group 5w2; recreation group 11.

Cathro and Tacoosh mucks (0 to 2 percent slopes) (Ck).—This mapping unit consists of organic soils 16 to 51 inches thick, over loam. The soils are in depressional areas on till plains. Cathro and Tacoosh soils have the profile described as representative of their respective series. The major difference between the soils is that Cathro soils are more decomposed than Tacoosh soils. Both of these soils are higher in reaction in the southern and western parts of Delta County than in the northern part of the survey area.

Included with these soils in mapping are some areas where the surface layer is mucky peat. Also included are a few small areas, on the eastern parts of the Stonington and Garden peninsulas, that are underlain by lacustrine clay. Bedrock is at a depth of more than 4 feet in some areas. Carbondale or Lupton soils are minor included areas in larger mapped areas. Poorly drained Ensley and Angelica soils are the most common included soils and are present near the edges of bogs. Chippeny soils are included in areas where bedrock is at a shallow or moderate depth.

These soils are used as woodland.

The major limitations to the use of these soils are wetness and hazard of frost. Capability unit VIIwc–10 (M/3c); woodland suitability group 5w2; recreation group 11.

Charlevoix Series

The Charlevoix series consists of somewhat poorly drained, nearly level or gently sloping soils on till plains. These soils formed in loamy material.

In a representative profile the surface layer is very dark brown sandy loam 2 inches thick. The subsurface layer is grayish-brown sandy loam 5 inches thick. The upper part of the subsoil is mottled, brown, friable sandy loam 9 inches thick; the middle part is mottled, brown, friable sandy loam 3 inches thick; and the lower part is mottled, dark-brown, friable loam 10 inches thick. The underlying material is mottled, brown sandy loam

Charlevoix soils have moderate available water capacity and medium natural fertility. Permeability is moderate. The seasonal high water table fluctuates between depths of 1 and 2 feet. These soils are excessively wet in spring and after heavy rains, but with adequate drainage the soils are easy to work and keep in good tilth. Runoff is slow, and water ponds in depressional areas for short periods.

Small areas of these soils have been cleared and are used for hay and pasture, but most areas are used as woodland.

Representative profile of Charlevoix sandy loam, 0 to 4 percent slopes, in a wooded area, 700 feet east of the southwest corner of sec. 12, T. 40 N., R. 24 W., Delta County:

A1—0 to 2 inches, very dark brown (10YR 2/2) sandy loam; moderate, medium, granular structure; very friable; less than 2 percent coarse fragments; slightly acid; clear, smooth boundary.

A2 2 to 7 inches, grayish-brown (10YR 5/2) sandy loam; weak, medium, granular structure; very friable; less than 2 percent coarse fragments; slightly acid; abrupt, wavy boundary.

B2ir—7 to 16 inches, brown (7.5YR 5/2) sandy loam; common, medium, faint, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; slightly acid; clear ,wavy boundary.

A'2—16 to 19 inches, brown (10YR 5/3) sandy loam; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, platy structure; friable; less than 2 percent coarse fragments; slightly acid; clear, irregular boundary.

B'2t—19 to 29 inches, dark-brown (7.5YR 4/4) loam; common, medium, faint, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few thin clay films on faces of peds; few tongues of brown (10YR 5/3) A'2 material in upper 4 inches; less than 2 percent coarse fragments; neutral; clear, wavy boundary.

C—29 to 60 inches, brown (7.5YR 5/4) sandy loam; many, medium, distinct, reddish-yellow (7.5YR 6/8) mottles; massive; friable; 3 percent coarse fragments; slightly effervescent; mildly alkaline.

The solum ranges from 16 to 36 inches in thickness. Reaction of the solum is slightly acid to neutral. Limestone slabs are in the profile in some areas.

The Ap horizon is very dark gray (10YR 3/1) and is 7 to 9 inches thick. The A1 horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. The A2 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2.

The B2ir horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4. It is sandy loam or loam.

The A'2 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2 or 3. It is sandy loam or loamy sand.

The B'2t horizon is dark brown (7.5YR 4/4) and reddish brown (5YR 4/4). It ranges from heavy sandy loam to light sandy clay loam. The weighted average clay content between depths of 10 and 40 inches is less than 18 percent.

The C horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4. It is dominantly sandy loam but grades to loam in places. The C horizon is as much as 5 percent coarse fragments.

Charlevoix soils are in landscape positions similar to those of Brimley, Kawkawlin, and Sundell soils. They are less stratified than Brimley soils. They are coarser textured than Kawkawlin soils. They are deeper over bedrock than Sundell soils.

Charlevoix sandy loam, 0 to 4 percent slopes (ClA).—This soil is in drainageways and depressions within areas of Onaway, Trenary, and Emmet soils and in narrow transitional areas between Onaway or Trenary soils and Ensley and Angelica soils; and it occurs as islands in large areas of Ensley and Angelica soils.

Included with this soil in mapping are a few areas of poorly drained Ensley and Angelica soils and some areas of well drained or moderately well drained Trenary and Onaway soils. Also included are some areas where the subsoil and underlying material are loam.

Most of this soil is used as woodland. Small areas are used for hay and pasture. Not all areas have adequate tile outlets. Seasonal wetness and a slight hazard of frost are the major limitations to the use of this soil for crops. Capability unit IIwc–6 (3b); woodland suitability group 2o5; recreation group 8.

Chatham Series

The Chatham series consists of well drained or moderately well drained, nearly level to moderately steep soils on till plains. The soils formed in 20 to 40 inches of loamy material over sandy material.

In a representative profile the surface layer is very dark gray fine sandy loam 6 inches thick. The subsurface layer is brown fine sandy loam 3 inches thick. The upper part of the subsoil is dark reddish-brown, friable fine sandy loam 4 inches thick; the middle part is yellowish-red, friable sandy loam 3 inches thick; and the lower part is dark-brown, friable sandy loam that is 7 inches thick and contains many limestone and sandstone flags and cobbles. The underlying material is brown and dark yellowish-brown gravelly loamy sand, and it contains many limestone and sandstone flags and stones.

Chatham soils have moderate available water capacity in the loamy layers and low available water capacity in the sandy layers. Natural fertility is medium. Permeability is moderately rapid.

More than half of the acreage of Chatham soils has been cleared. The soils are used for hay, oats, and pasture. Some areas are idle. The remaining acreage is used as woodland.

Representative profile of Chatham fine sandy loam, 2 to 6 percent slopes, in a cultivated area, in the SW¼SE¼NE¼ sec. 29, T. 46 N., R. 21 W., Alger County:

Ap—0 to 6 inches, very dark gray (10YR 3/1) fine sandy loam; weak, medium, granular structure; friable; 2 percent coarse fragments; mildly alkaline; abrupt, smooth boundary.

A2—6 to 9 inches, brown (7.5YR 5/2) fine sandy loam; weak, fine, subangular blocky structure; friable; 2 percent coarse fragments; mildly alkaline; abrupt, broken boundary.

B21hir—9 to 13 inches, dark reddish-brown (5YR 3/4) fine sandy loam; weak, fine, subangular blocky structure; friable; 2 percent coarse fragments; mildly alkaline; abrupt, wavy boundary.

B22ir—13 to 16 inches, yellowish-red (5YR 4/6) sandy loam; weak, fine, subangular blocky structure; friable; 2 percent coarse fragments; mildly alkaline; abrupt, wavy boundary.

B23—16 to 23 inches, dark-brown (7.5YR 4/4 and 3/2) sandy loam; weak, medium, subangular blocky structure; friable; 15 percent glauconitic sandstone and limestone, high degree of weathering; 15 percent coarse fragments; mildly alkaline; abrupt, wavy boundary.

IIC—23 to 60 inches, brown (10YR 5/3) and dark yellowish-brown (10YR 4/4) gravelly loamy sand that contains many stones and flags of partly weathered glauconitic sandstone and limestone; single grained; loose; 25 percent coarse fragments; strongly effervescent; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness, but it is typically 20 to 30 inches thick. Thickness of the solum corresponds to the depth to the IIC horizon. Reaction throughout the solum ranges from slightly acid to mildly alkaline.

In undisturbed areas there is a black (10YR 2/1) A1 horizon 1 to 3 inches thick. The Ap horizon ranges from dark reddish brown (5YR 2/2) to very dark gray (10YR 3/1). The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. It is fine sandy loam or loam.

The B21hir horizon has hue of 5YR or 7.5YR, value of 2 to 4, and chroma of 2 to 4. It is fine sandy loam or loam. The B22ir horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 or 6. It is fine sandy loam or loam. The B23 horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4 or 6. It is fine sandy loam or sandy loam.

The IIC horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 3 to 6. It ranges from gravelly loamy sand to gravelly sandy loam. Pockets of gravel are common, and slabs and boulders of partly weathered glauconitic limestone and sandstone are common. The IIC horizon ranges from neutral to moderately alkaline in reaction.

Chatham soils are near Longrie and Trenary soils. They lack the bedrock within a depth of 20 to 40 inches that is characteristic of Longrie soils. They have coarser textured underlying material than Trenary soils.

Chatham fine sandy loam, 0 to 2 percent slopes (CmA).—This soil is on till plains. Runoff is slow. The hazard of erosion is slight.

Included with this soil in mapping are a few areas of Longrie and Trenary soils. Also included are some areas where limestone bedrock is below a depth of 4 feet.

Some areas of this soil are used as woodland. Most areas have been cleared and are used for oats, hay, and pasture. The major limitations to the use of this soil are moderate droughtiness and a slight hazard of erosion. Capability unit IIs-2 (3a); woodland suitability group 2o1; recreation group 4.

Chatham fine sandy loam, 2 to 6 percent slopes (CmB).—This soil is on till plains. It has the profile described as representative of the series. Runoff is slow. The hazard of erosion is moderate.

Included with this soil in mapping are a few areas of Longrie and Trenary soils. Also included are some areas where limestone bedrock is below a depth of 4 to 6 feet.

About half of the acreage of this soil is used as woodland, and half has been cleared and is used mainly for hay, oats, and pasture. This soil responds well to good management and is well suited to adapted crops. It tends to be droughty during long dry periods.

The major limitations to the use of this soil are a hazard of erosion and seasonal droughtiness. Capability unit IIe-3 (3a); woodland suitability group 2o1; recreation group 4.

Chatham fine sandy loam, 6 to 18 percent slopes (CmD).—This soil is on till plains. Most areas have short, single slopes, but some areas have complex slopes. Runoff is medium to rapid. The hazard of erosion is moderate to severe.

Included with this soil in mapping are a few areas of Chatham soils that have steeper slopes or less steep slopes. Also included are a few areas of moderately eroded soils.

This soil is used for hay, oats, pasture, and woodland, or it is idle. If it is used for crops, more intensive management is required on this soil than on less sloping Chatham soils.

The major limitations to the use of this soil for crops are moderate droughtiness, small size of the soil areas, short slopes, and the hazard of erosion. Capability unit IIIe-6 (3a); woodland suitability group 2o1; recreation group 6.

Chippeny Series

The Chippeny series consists of very poorly drained, nearly level to moderately steep organic soils on till plains and bedrock benches. The soils formed in organic material derived from woody plants and are underlain by limestone bedrock at a depth of 20 to 51 inches.

In a representative profile the surface layer is black muck (sapric material) 6 inches thick. The next layer is very dark gray muck (sapric material) 14 inches thick. The underlying material is dark grayish-brown silty clay loam 8 inches thick over limestone bedrock.

Chippeny soils have very high available water capacity and low natural fertility. Permeability above the bedrock is rapid in the muck and rapid to moderately slow in the mineral soil, but downward movement of water is impeded by a seasonal high water table and bedrock. The seasonal high water table is at or near the surface most of the year but drops to a depth of about 2 feet in midsummer. Runoff is very slow or ponded.

Chippeny soils are used as woodland. Many of the areas are used by deer as yarding areas in winter.

Representative profile of Chippeny muck, from an area of Chippeny muck, in a wooded area, in the southwest corner of sec. 3, T. 41 N., R. 21 W., Delta County:

Oa1—0 to 3 inches, black (5YR 2/1, broken face, rubbed, and pressed) sapric material; about 25 percent fiber, less than 5 percent rubbed; weak, fine, granular structure; nonsticky; about 60 percent woody fibers and 40 percent herbaceous fibers; mildly alkaline; clear, smooth boundary.

Oa2—3 to 6 inches, black (5YR 2/1, broken face) sapric material, dark reddish brown (5YR 2/2 rubbed and pressed); about 50 percent fiber, less than 5 percent rubbed; weak, medium, granular structure; nonsticky; about 60 percent woody fibers and 40 percent herbaceous fibers; mildly alkaline; clear, smooth boundary.

Oa3—6 to 20 inches, very dark gray (5YR 3/1), broken face, rubbed, and pressed) sapric material; about 17 percent fiber, less than 5 percent rubbed; massive; nonsticky; about 60 percent woody fibers and 40 percent herbaceous fibers; mildly alkaline; gradual, smooth boundary.

IIC—20 to 28 inches, dark grayish-brown (2.5Y 4/2) silty clay loam; massive; sticky; mildly alkaline; abrupt, smooth boundary.

IIIR—28 inches, limestone bedrock.

Depth to limestone bedrock ranges from 20 to 51 inches but is dominantly about 20 to 40 inches. Reaction of the organic material ranges from medium acid to mildly alkaline. Most of the organic material is woody, but some is herbaceous. Woody fragments as large as 2 or 3 inches in diameter are common.

The surface tier is sapric or hemic material. The subsurface tier and the bottom tier, where present, are dominantly sapric material. The organic layers have hue of 5YR to 10YR, value of 2 or 4, and chroma of 1 to 3. The organic layers commonly have weak, granular, or blocky structure, but in places they are massive.

The mineral IIC horizon ranges from 0 to 12 inches in thickness and from loamy sand to silty clay loam. It has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 to 4. The IIC horizon is neutral to moderately alkaline in reaction.

Chippeny soils are near Cathro, Tacoosh, Tawas, Carbondale, Lupton, and Rifle soils. They have underlying material of bedrock, which Cathro, Tacoosh, and Tawas soils lack. They have thinner organic layers than Carbondale, Lupton, and Rifle soils.

Chippeny muck (0 to 6 percent slopes) (Cn).—This soil is in nearly level or depressional areas on till plains and gently sloping areas on bedrock benches. Where this soil is on till plains, it is shallow over bedrock. Where this soil is on bedrock benches, the surface remains wet all year because of seepage from adjoining uplands. In northern Alger County this soil is underlain by sandstone that is slightly acid to neutral in reaction. In these areas the organic horizons are more acid than those in the profile described as representative of the Chippeny series.

Included with this soil in mapping are a few areas of Carbondale and Lupton soils near the center of large areas of this Chippeny soil and small areas of poorly drained Nahma or Tacoosh soils. Also included are some areas of soils in which the organic matter is less decomposed than it is in this Chippeny soil.

This soil is not used for farming, because of wetness and the hazard of frost. It provides food and cover for deer in winter. This soil is used as woodland. Capability unit VIIwc–10 (M/Rc); woodland suitability group 5w2; recreation group 11.

Croswell Series

The Croswell series consists of moderately well drained, nearly level or gently sloping soils on outwash plains, lake plains, and till plains. These soils formed in sandy material.

In a representative profile the surface layer is black organic matter and reddish-gray sand 2 inches thick. The subsurface layer is reddish-gray sand 3 inches thick. The upper part of the subsoil is reddish-brown, loose sand 5 inches thick; the middle part is strong-brown, loose sand 10 inches thick; and the lower part is brown, loose sand 8 inches thick. The underlying material begins at a depth of 28 inches. The upper 12 inches is mottled, light yellowish-brown sand, and the lower part is mottled, light-brown sand.

Croswell soils have very low available water capacity and low natural fertility. Permeability is rapid. Depth to the seasonal high water table ranges from about 2 feet during wet seasons to more than 3 feet during dry seasons. Runoff is very slow.

Because these soils are sandy and droughty, only a very small acreage is used for crops. Most cleared areas are idle or are planted to red pine or jack pine. Nearly all areas of the Croswell soils are used as woodland.

Representative profile of Croswell sand, 0 to 4 percent slopes, in an uncultivated field, in the NE¼SE¼SW¼ sec. 13, T. 39 N., R. 23 W., Delta County:

O1&A2—0 to 2 inches, black (5YR 2/1) organic matter and reddish-gray (5YR 5/2) sand; very weak, granular structure; very friable; very strongly acid; abrupt, smooth boundary.

A2—2 to 5 inches, reddish-gray (5YR 5/2) sand; single grained; loose; strongly acid; abrupt, wavy boundary.

B21ir—5 to 10 inches, reddish-brown (5YR 4/4) sand; single grained; loose; strongly acid; gradual, wavy boundary.

B22ir—10 to 20 inches, strong-brown (7.5YR 5/6) sand; single grained; loose; strongly acid; gradual, wavy boundary.

B3—20 to 28 inches, brown (7.5YR 5/4) sand; single grained; loose; medium acid; gradual, wavy boundary.

C1—28 to 40 inches, light yellowish-brown (10YR 6/4) sand; many, medium, prominent, yellowish-red (5YR 5/8) mottles; single grained; loose; medium acid; clear, wavy boundary.

C2—40 to 60 inches, light-brown (7.5YR 6/4) sand; few, fine, distinct, yellowish-brown (10YR 5/6) mottles in the upper 5 inches; single grained; loose; slightly acid.

The solum ranges from 24 to 42 inches in thickness. Reaction throughout the solum ranges from very strongly acid to medium acid.

A black (N 2/0) A1 horizon, 1 to 2 inches thick, is present in some places. The lower boundary of the A2 horizon ranges from smooth to irregular. The A2 horizon has hue of 10YR to 5YR, value of 5 or 6, and chroma of 2.

The B21ir horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 4. The B22ir horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 4 to 8. The B3 horizon has hue of 7.5YR, value of 5 or 6, and chroma of 4 to 8.

The C horizon has hue of 10YR to 5YR, value of 5 to 7, and chroma of 3 or 4. It is medium acid or slightly acid. Depth to mottling ranges from 20 to 40 inches.

Croswell soils are near Au Gres, Grayling, and Rubicon soils. They lack the mottled B horizon that is characteristic of Au Gres soils. They have mottles within a depth of 40 inches, which are lacking in Grayling and Rubicon soils.

Croswell sand, 0 to 4 percent slopes (CrA). —This soil is on lake plains, outwash plains, and till plains. The hazard of soil blowing is severe.

Included with this soil in mapping are a few areas of Rubicon soils. Also included in depressional areas are somewhat poorly drained Au Gres soils.

Nearly all the acreage of this soil is used as woodland. Areas used for crops generally are small tracts in larger fields of finer textured soils.

The major limitations to the use of this soil for crops are low natural fertility, droughtiness, and the hazard of soil blowing. Capability unit IVs–4 (5a); woodland suitability group 2s3; recreation group 1.

Dawson Series

The Dawson series consists of very poorly drained, nearly level or depressional, extremely acid organic soils on outwash plains and lake plains. The soils formed in 16 to 51 inches of mainly herbaceous organic deposits underlain by sandy material.

In a representative profile the surface layer is dark reddish-brown peat (fibric material) 8 inches thick. Most of the fibers are sphagnum moss. The next layer is dark reddish-brown muck (sapric material) 30 inches thick. The underlying material is at a depth of 38 inches. The upper 2 inches is very dark gray silt loam, and the lower part is grayish-brown sand.

Dawson soils have very high available water capacity in the organic layers and very low available water capacity in the sandy layer. They are low in natural fertility. Permeability is rapid in the organic layers and rapid in the sandy underlying material. Downward movement of water is impeded by the seasonal high water table, which is at the surface most of the year. The water table drops to a depth of 24 to 30 inches during extended dry periods in some areas. Runoff is slow or ponded.

Some Dawson soils are in woodland. Tree species, however, are limited to a few slow-growing black spruce or white pine.

Representative profile of Dawson peat, from an area of Dawson and Greenwood peats, in an open bog, in the southwest corner of SE¼NE¼ sec. 16, T. 41, N., R. 20 W., Delta County:

Oi—0 to 8 inches, dark reddish-brown (5YR 3/3), dark reddish-brown (5YR 3/2, rubbed) fibric material, and pinkish gray (5YR 7/2, pressed); about 95 percent fiber, 90 percent rubbed; massive; nonsticky; fibers are mainly sphagnum moss; extremely acid; abrupt, smooth boundary.

Oa—8 to 38 inches, dark reddish-brown (5YR 3/2, broken face and pressed) sapric material, dark reddish brown (5YR 2/2, rubbed); about 40 percent fiber, less than 10 percent rubbed; massive; nonsticky; fibers are mainly herbaceous; extremely acid; abrupt, smooth boundary.

IIA1b—38 to 40 inches, very dark gray (10YR 3/1) silt loam; massive; slightly sticky; extremely acid; clear, smooth boundary.

IIIC—40 to 60 inches, grayish-brown (2.5Y 5/2) sand; single grained; nonsticky; extremely acid.

The organic material ranges from 16 to 51 inches in thickness, but most commonly it is 20 to 40 inches thick. Reaction of the organic material is extremely acid or very strongly acid.

The upper tier is dominantly fibric sphagnum moss. The upper 4 or 5 inches commonly is living sphagnum moss that grades into moss that has undergone some decomposition.

The Oi horizon ranges from about 4 to 14 inches in thickness. Fiber content ranges from 75 to 95 percent when unrubbed and 40 to 90 percent when rubbed. Broken face colors include hue of 5YR to 10YR, value of 3 to 6, and chroma of 3 or 4.

The subsurface tier is dominantly sapric material. It has hue of 5YR to 10YR, value of 2 to 4, and chroma of 1 to 3. This tier generally is massive.

The IIA1b horizon is not present in all places. The IIIC horizon is sand or loamy sand. It has hue of 10YR to 2.5Y, value of 4 to 6, and chroma of 1 to 3. The IIIC horizon is extremely acid to strongly acid in reaction.

Dawson soils are near Carbondale, Lupton, Rifle, Greenwood, Kinross, and Tawas soils. They are more acid and have thinner organic layers than Carbondale, Lupton, and Rifle soils. They have more organic material over sand than Kinross soils. They are more acid than Tawas soils.

Dawson peat (0 to 2 percent slopes) (Da).—This nearly level or depressional soil is on outwash plains and lake plains.

Included with this soil in mapping are some areas of poorly drained Kinross soils around the perimeter of this soil. Also included are a few areas of soils in which the subsurface layer has slightly more fiber than is in the subsurface layer of this Dawson soil.

Horizontal movement of water is slow through this soil because outlets are restricted. The seasonal high water table is near the surface most of the year. This soil supports sparse stands of black spruce and a few white pine and jack pine trees. Many of the bogs support mainly sphagnum moss, leatherleaf, bog rosemary, and scattered black spruce trees. The densest tree growth generally is near the bog borders.

The major limitations to the use of this soil are wetness, extreme acidity, and the hazard of frost. Capability unit VIIIwc–1 (Mc–a); woodland suitability group not assigned; recreation group 11.

Dawson and Greenwood peats (0 to 2 percent slopes) (Dd).—The nearly level or depressional soils in this mapping unit are in bogs on outwash plains and lake plains. These soils differ mainly in thickness. Dawson soils are 16 to 51 inches of acid organic material over sand, and Greenwood soils are more than 51 inches of acid organic material over mineral material. Dawson soils are slightly more decomposed below a depth of 12 inches than Greenwood soils. A Dawson soil in this mapping unit has the profile described as representative of the Dawson series.

Some areas of this mapping unit are nearly all Dawson soils, and a few are nearly all Greenwood soils. In most places, particularly in large areas, the border of the bogs is Dawson soils and the center of the bogs is Greenwood soils. A narrow band of Kinross soils borders some areas of this mapping unit.

Horizontal movement of water is very slow through these soils because they have restricted outlets. This causes poor aeration, which, along with strong acidity, limits vegetation to black spruce trees, sphagnum moss, leatherleaf, and bog rosemary (fig. 6). Some areas support a few white pine and jack pine. Growth of trees is very slow. The densest stands of trees generally are near the bog borders.

Figure 6.—**Plant cover in an area of Dawson and Greenwood peats. These very acid organic soils generally support leatherleaf, sphagnum moss, and scattered stands of black spruce and jack pine.**

The major limitations to the use of these soils are wetness, acidity, and hazard of frost. Capability unit VIIIwc 1 (Mc–a); woodland suitability group not assigned; recreation group 11.

Deerton Series

The Deerton series consists of well drained or moderately well drained, nearly level to moderately steep soils on sandstone benches and till plains near Lake Superior. These soils formed in 20 to 40 inches of sandy material overlying sandstone bedrock.

In a representative profile the surface layer is black and very dark gray sand and organic matter 1 inch thick. The subsurface layer is pinkish-gray sand 7 inches thick. The upper part of the subsoil is dark reddish-brown, very friable loamy sand 1 inch thick, and the lower part is reddish-brown, loose sand 15 inches thick that contains some chunks of weakly cemented soil material. The underlying material is dark yellowish-brown and very pale brown soft sandstone that becomes firmer with increasing depth and is hard at a depth of 38 inches.

Deerton soils have low available water capacity and low natural fertility. Permeability is rapid. Downward movement of water is impeded by bedrock. Some of the bedrock is hard, but much of it is soft and highly weathered in the upper part and can be easily removed by backhoes or trenchers. The areas of least resistant bedrock are east of Au Train and west of Munising.

Deerton soils are used as woodland.

Representative profile of Deerton sand, 0 to 6 percent slopes, in a wooded area, in the NE¼SE¼SE¼ sec. 27, T. 47 N., R. 20 W., Alger County:

A1 0 to 1 inch, black (5YR 2/1) and very dark gray (N 3/0) sand and organic matter; weak, fine, granular structure; very friable; extremely acid; abrupt, smooth boundary.

A2—1 to 8 inches, pinkish-gray (5YR 6/2) sand; weak, fine, granular structure; very friable; extremely acid; abrupt, irregular boundary.

B21hir—8 to 9 inches, dark reddish-brown (5YR 3/2) loamy sand; very weak, fine, subangular blocky structure; very friable; very strongly acid; abrupt, irregular boundary.

B22ir—9 to 24 inches, reddish-brown (5YR 4/4) sand; single grained; loose; few weakly cemented chunks of ortstein; very strongly acid; gradual, smooth boundary.

IIC—24 to 38 inches, dark yellowish-brown (10YR 4/4) and very pale brown (10YR 8/3) highly weathered and fractured sandstone bedrock; medium acid.

IIR—38 inches, dark yellowish-brown (10YR 4/4) and very pale brown (10YR 8/3) consolidated sandstone bedrock.

The thickness of the solum and depth to bedrock range from 20 to 40 inches but are dominantly 24 to 36 inches. The solum contains many sandstone slabs and fragments in places.

Reaction of the solum ranges from extremely acid to medium acid.

The A1 horizon is black (5YR 2/1) to dark gray (5YR 4/1). The A2 horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2.

The B21hir horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 2 or 3. It is sand or loamy sand. The B22ir horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 4 or 6. Weakly cemented chunks of ortstein are present in some places.

A thin C horizon that has hue of 5YR to 10YR, value of 3 to 6, and chroma of 3 or 4 is present in a few places. The IIC horizon commonly is highly weathered and soft in the upper part, becoming firmer with increasing depth.

Deerton soils are near Kalkaska, Kawbawgam, and Onota soils. They have sandstone bedrock at a moderate depth, which Kalkaska soils lack. They are coarser textured than Kawbawgam soils and lack mottles in the B horizon that are characteristic of Kawbawgam soils. They are coarser textured throughout the solum than Onota soils.

Deerton sand, 0 to 6 percent slopes (DeB).—This soil is on till plains and bedrock benches. It has the profile described as representative of the series. Runoff is slow.

Included with this soil in mapping are areas of Onota soils, a few areas where depth to bedrock is more than 40 inches, and some areas where depth to bedrock is less than 20 inches. Also included are a few depressional areas of somewhat poorly drained Kawbawgam soils.

This soil is used as woodland. More balsam fir and hemlock are present on this soil than on the more sloping Deerton soils.

The major limitations to the use of this soil for crops are low natural fertility, droughtiness, depth to bedrock, and the hazard of soil blowing. Capability unit IVs–1 (4/Ra); woodland suitability group 3s1; recreation group 1.

Deerton sand, 6 to 18 percent slopes (DeD).—This soil is on sandstone benches. Runoff is slow to medium. The hazard of erosion is moderate.

Included with this soil in mapping are a few areas where the soil is less than 20 inches thick. Also included are a few areas where slopes are more than 18 percent.

This soil is used as woodland.

The major limitations to the use of this soil for crops are low natural fertility, droughtiness, steepness, and depth to bedrock. Capability unit IVs–1 (4/Ra); woodland suitability group 3s1; recreation group 3.

Deerton-Burt complex, 0 to 6 percent slopes (DlB).—The soils in this mapping unit are on bedrock. Runoff is slow. About 55 percent of this mapping unit is Deerton sand, and about 35 percent is Burt mucky sandy loam. The remaining 10 percent is included soils.

Deerton soils in this complex are mostly less than 24 inches deep over bedrock. They are generally more stony than Deerton soils in other areas. Burt soils are 10 to 20 inches deep over bedrock.

Included with these soils in mapping are some areas of well-drained sandy soils that are less than 20 inches deep and some poorly drained soils that are less than 10 inches deep. Also included are occasional sandstone outcrops.

These soils are used as woodland.

The major limitations to the use of these soils are shallow soil depth, stoniness, and wetness. Capability unit IVs–1 (4/Ra, Rbc); woodland suitability group 3s1 for Deerton, 4w1 for Burt; recreation group 12.

Deford Series

The Deford series consists of poorly drained, nearly level or depressional soils on lake plains. These soils formed in sandy lacustrine materials.

In a representative profile the surface layer is black muck 3 inches thick. The subsurface layer is very dark brown loamy fine sand 3 inches thick. The underlying material, which extends to a depth of 60 inches or more, is mottled, grayish-brown, very friable loamy fine sand.

Deford soils have low available water capacity and low natural fertility. Permeability is rapid. The seasonal high water table is near the surface most of the year but drops to below a depth of 2 feet during extended dry periods. Runoff is very slow or ponded.

Except for a few areas that are used for pasture or are idle, Deford soils are used as woodland.

Representative profile of Deford loamy fine sand, in a wooded area, in the SE¼NW¼NW¼ of sec. 10, T. 40 N., R. 21 W., Delta County:

O2—3 inches to 0, black (10YR 2/1) muck; weak, coarse, granular structure; friable; medium acid; abrupt, smooth boundary.

A1—0 to 3 inches, very dark brown (10YR 2/2) loamy fine sand; weak, medium, angular blocky structure, very friable; slightly acid; clear, wavy boundary.

C1g—3 to 9 inches, grayish-brown (2.5Y 5/2) loamy fine sand; few, medium, faint, dark-gray (10YR 4/1) mottles; very weak, coarse, subangular blocky structure; very friable; slightly acid; abrupt, smooth boundary.

C2g—9 to 21 inches, grayish-brown (10YR 5/2) loamy fine sand; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; very weak, coarse, subangular blocky structure; very friable; neutral; gradual, smooth boundary.

C3g—21 to 60 inches, grayish-brown (10YR 5/2) loamy fine sand; common, fine, prominent, strong-brown (7.5YR 5/8) mottles; very weak, coarse, subangular blocky structure; very friable; neutral.

Reaction commonly ranges from medium acid to neutral throughout the profile, but in places it is neutral to moderately alkaline below a depth of 20 or 30 inches.

The O2 horizon is black (10YR 2/1 or 5YR 2/1). The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2).

The C1g horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. It is fine sand or loamy fine sand. There is normally only a difference of one in value between the C2g and C3g horizons. The C2g and C3g horizons have hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2. They are fine sand or loamy fine sand. In a few places thin bands, ½ inch to 2 inches thick, of medium sand, silt, or clay are in the C3g horizon.

Deford soils are in landscape positions similar to those of Bruce soils, coarse variant, and Roscommon soils. They are coarser textured throughout the profile than Bruce soils, coarse variant, and are finer textured throughout the profile than Roscommon soils.

Deford loamy fine sand (0 to 2 percent slopes) (Dm).—This nearly level or depressional soil is on lake plains.

Included with this soil in mapping are a few areas of Tawas and Roscommon soils and a few areas of soils that have as much as 12 inches of muck on the surface. Also included are a few areas where the underlying material has brighter colors and is more acid than that of this Deford soil.

Most of this soil is used as woodland. Small cleared areas are used for pasture. Drainage is needed for crops. Tile is difficult to install, because of the lack of adequate outlets and the susceptibility of the soil to caving and flowing.

The major limitations to the use of this soil for crops are the seasonal high water table, inadequate drainage outlets in some areas, hazard of frost, and the hazard of soil blowing if the soil is drained. Capability unit IIIwc–6 (4c); woodland suitability group 5w1; recreation group 10.

Duel Series

The Duel series consists of well drained and moderately well drained, nearly level and gently sloping soils on lake plains and till plains. These soils formed in 20 to 40 inches of sandy material overlying limestone bedrock.

In a representative profile the surface layer is black forest litter 1 inch thick. The subsurface layer is light-gray loamy sand 6 inches thick. The upper part of the subsoil is dark reddish-brown, very friable loamy sand 2 inches thick; the middle part is reddish-brown, very friable sand 7 inches thick; and the lower part is strong-brown, very friable sand about 6 inches thick. The underlying material is brown sand 7 inches thick over dark-brown loamy sand 3 inches thick. Limestone bedrock is at a depth of 31 inches.

Duel soils have low available water capacity and low natural fertility. Permeability is rapid, but downward movement of water is slowed by bedrock. Runoff is slow.

Most of this soil is used as woodland. A small acreage is used for hay, oats, or pasture.

Representative profile of Duel loamy sand, 0 to 6 percent slopes, in a wooded area, in the SW¼NE¼SE¼ sec. 15, T. 41 N., R. 19 W., Delta County:

O2—1 inch to 0, black (N 2/0) decomposed forest litter and sand; sand makes up about 50 percent of the horizon; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—0 to 6 inches, light-gray (5YR 6/1) loamy sand; weak, medium, granular structure; very friable; slightly acid; abrupt, irregular boundary.

B21hir—6 to 8 inches, dark reddish-brown (5YR 3/3) loamy sand; very weak, medium, subangular blocky structure; very friable; few, discontinuous, weakly cemented chunks of ortstein; slightly acid; abrupt, wavy boundary.

B22ir—8 to 15 inches, reddish-brown (5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; slightly acid; gradual, wavy boundary.

B3—15 to 21 inches, strong-brown (7.5YR 5/6) sand; very weak, medium, subangular blocky structure; very friable; slightly acid; gradual, wavy boundary.

C1—21 to 28 inches, brown (7.5YR 5/4) sand; single grained; loose; neutral; abrupt, smooth boundary.

C2—28 to 31 inches, dark-brown (7.5YR 3/2) loamy sand; massive; friable; about 10 percent, by volume, small limestone fragments; slightly effervescent; moderately alkaline; abrupt, smooth boundary.

IIR—31 inches, limestone bedrock.

The solum ranges from 18 to 36 inches in thickness. Depth to bedrock ranges from 20 to 40 inches. Reaction throughout the solum ranges from strongly acid to slightly acid.

In some areas there is a black (5YR 2/1) or very dark brown (10YR 2/2) A1 horizon 1 to 3 inches thick. The A2 horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 1 or 2.

The B21hir horizon has hue of 5YR, value of 3 or 4, and chroma of 3 or 4. It is sand or loamy sand. The B22ir horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 8. It is sand or loamy sand. The B3 horizon has hue of 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is sand or loamy sand.

The C1 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 8. It is sand or loamy sand. The C2 horizon has hue of 7.5YR to 10YR, value of 3 or 4, and chroma of 2 to 4. It is loamy sand, sandy loam, or loam. Mottling is below a depth of 20 inches where the profile is moderately well drained.

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Duel soils are near Kalkaska, Longrie, and Rubicon soils. They are coarser textured throughout the profile than Longrie soils. They have bedrock within a depth of 20 to 40 inches, which is lacking in Kalkaska and Rubicon soils.

Duel loamy sand, 0 to 6 percent slopes (DuB).—This soil is on outwash plains and till plains. The hazard of soil blowing is severe.

Included with this soil in mapping are a few areas of Rubicon sand. Also included are a few areas of Longrie soils.

Most of this soil is used as woodland. Some areas formerly cleared are now idle.

The major limitations to the use of this soil for crops are droughtiness, low natural fertility, depth to bedrock, and the hazard of soil blowing. Capability unit IVs–1 (4/Ra); woodland suitability group 3s1; recreation group 1.

East Lake Series

The East Lake series consists of well drained or moderately well drained, nearly level or gently sloping soils on outwash plains and old beach ridges. These soils formed in a sandy layer 20 to 40 inches thick over stratified gravelly and sandy materials.

In a representative profile the surface layer is black sand 1 inch thick. The subsurface layer is light brownish-gray sand 6 inches thick. The upper part of the subsoil is dark reddish-brown, very friable sand 3 inches thick; the middle part is dark-brown, very friable sand 15 inches thick; and the lower part is yellowish-brown, very friable sand 11 inches thick. The underlying material begins at a depth of 36 inches. It is pale-brown coarse sand and gravel.

East Lake soils have low available water capacity and low natural fertility. Permeability is rapid, and runoff is slow.

Only a small acreage of East Lake soils is used for hay or pasture. Most of the acreage is used as woodland. These soils are a good source of gravel.

Representative profile of East Lake sand, 0 to 6 percent slopes, in a wooded area, on the south side of a gravel pit SE¼NW¼ sec. 24, T. 40 N., R. 20 W., Delta County:

A1—0 to 1 inch, black (N 2/0) sand; very weak, medium, granular structure; very friable; slightly acid; abrupt, smooth boundary.

A2—1 to 7 inches, light brownish-gray (10YR 6/2) sand; very weak, medium, granular structure; very friable; slightly acid; abrupt, wavy boundary.

B21hir—7 to 10 inches, dark reddish-brown (5YR 2/2) sand; very weak, coarse, subangular blocky structure; very friable; slightly acid; abrupt, broken boundary.

B22ir—10 to 25 inches, dark-brown (7.5YR 4/4) sand; very weak, coarse, subangular blocky structure; very friable; slightly acid; gradual, wavy boundary.

B3—25 to 36 inches, yellowish-brown (10YR 5/4) sand; very weak, coarse, subangular blocky structure; very friable; slightly acid; abrupt, smooth boundary.

IIC—36 to 60 inches, pale-brown (10YR 6/3) stratified coarse sand and gravel; single grained; loose; strongly effervescent; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness, which corresponds with the depth to gravelly material. Reaction throughout the solum is medium acid to slightly acid.

In cultivated areas the Ap horizon is dark brown (7.5YR 3/2). The A1 horizon is black (N 2/0 or 10YR 2/1). The A2 horizon has hue of 7.5YR or 10YR, value of 6 or 7, and chroma of 1 or 2.

The B21hir horizon has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 2 or 3. The B21hir horizon is commonly discontinuous and is thinnest where the colors are darkest (5YR 2/2 or 5YR 3/2). It is sand or loamy sand. The B22ir horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 or 6. It is sand or loamy sand. The B3 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 4 or 6. It is sand or loamy sand.

In a few profiles there is a light yellowish-brown (10YR 6/4) C horizon. The IIC horizon is dark grayish brown (10YR 4/2), pale brown (10YR 6/3), or light yellowish brown (10YR 6/4). The percentage of sand, gravel, and fragments the size of cobblestones varies from place to place.

East Lake soils are in positions similar to those of East Lake, acid variant, Eastport, Kalkaska, Kiva, and Mancelona soils. They have a less acid IIC horizon than East Lake soils, acid variant. They lack the deep sand profile of Kalkaska and Eastport soils. They have a thicker, coarser textured solum than Kiva soils. They lack a layer that has a high clay content in the lower part of the B horizon, which is characteristic of Mancelona soils.

East Lake sand, 0 to 6 percent slopes (EaB).—This soil is on outwash plains and old beach ridges. The hazard of erosion is slight if sufficient plant cover is maintained to protect the surface from soil blowing.

Included with this soil in mapping are small areas of somewhat poorly drained Au Gres soils in slight depressions within broader areas of this soil. Also included are areas of Rubicon or Kalkaska soils, where these soils are on the same landscape with this East Lake soil, and areas of Eastport soils on some old beach ridges.

Most of this soil is used as woodland. Small areas are cleared and are used for hay or pasture.

The major limitations to the use of this soil for crops are low natural fertility, droughtiness, and susceptibility to soil blowing. This soil is a good source of gravel. Capability unit IVs-4 (5a); woodland suitability group 3s1; recreation group 1.

East Lake Series, Acid Variant

The East Lake series, acid variant, consists of well drained or moderately well drained, nearly level to moderately steep soils on outwash plains. These soils formed in a sandy layer 15 to 40 inches thick over sandy and gravelly material.

In a representative profile the surface layer is very dark grayish-brown loamy sand 2 inches thick. The subsurface layer is brown loamy sand 3 inches thick. The upper part of the subsoil is dark-brown, friable loamy sand 8 inches thick, and the lower part is dark reddish-brown, friable loamy sand 13 inches thick. The underlying material begins at a depth of 26 inches. It is reddish-brown to brown sand and gravel.

East Lake soils, acid variant, have low available water capacity and low natural fertility. Permeability is rapid.

These soils are used as woodland and as sources of gravel borrow material.

Representative profile of East Lake loamy sand, acid variant, 6 to 18 percent slopes, in a wooded area, in a gravel pit in the SE¼SW¼ sec. 6, T. 46 N., R. 20 W., Alger County:

A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—2 to 5 inches, brown (7.5YR 5/2) loamy sand; weak, fine, granular structure; very friable; medium acid; abrupt, wavy boundary.

B21ir—5 to 13 inches, dark-brown (7.5YR 3/2) loamy sand; weak, medium, granular structure; friable; medium acid; abrupt, wavy boundary.

B22ir—13 to 26 inches, dark reddish-brown (5YR 3/3) loamy sand; weak, medium, granular structure; friable; medium acid; clear, wavy boundary.

IIC—26 to 60 inches, reddish-brown (5YR 4/3) to brown (7.5YR 5/4) sand and gravel; single grained; loose; medium acid.

The solum ranges from 15 to 40 inches in thickness but is most commonly 20 to 30 inches thick, which corresponds to the depth to the IIC horizon. In some profiles the solum is cobbly. Reaction throughout the profile is strongly acid to medium acid.

The A1 horizon has hue of 10YR to 5YR, value of 2 or 3, and chroma of 1 or 2. The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2.

The B21ir horizon has hue of 7.5YR or 5YR, value of 2 or 3, and chroma of 2 or 3. The B22ir horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 3 to 6. In places there is a gravelly loamy sand B3 horizon that has colors transitional to the IIC horizon.

The IIC horizon has hue of 5YR to 10YR, value of 4 or 6, and chroma of 3 or 4. The percentage of sand, gravel, and cobblestones in the IIC horizon varies considerably.

East Lake soils, acid variant, are near Kalkaska and Munising soils. They have a finer textured B horizon than Kalkaska soils. They have gravel in the C horizon, which is lacking in Kalkaska soils. They are coarser textured through most of the profile than Munising soils, and they lack the fragipan of Munising soils.

East Lake loamy sand, acid variant, 0 to 6 percent slopes (EcB).—This soil is on outwash plains. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of soils that are cobbly throughout the profile and some areas where the surface layer ranges to sandy loam. Also included are areas of Kalkaska and Munising soils, the main included soils, and some areas where the depth to gravel deposits ranges from about 4 feet to more than 20 feet.

This soil is used as woodland and as a source of gravel. The quality of the gravel is variable.

The major limitations to the use of this soil for crops are low natural fertility, droughtiness, and susceptibility to soil blowing. Capability unit IIIs-4 (4a-a); woodland suitability group 2s1; recreation group 2.

East Lake loamy sand, acid variant, 6 to 18 percent slopes (EcD).—This soil is on outwash plains. It has the profile described as representative of the series. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping are some small areas of soils that are cobbly at the surface and areas where the surface layer ranges to sandy loam; texture generally depends on the nearby soils. Also included are Kalkaska and Munising soils, the main included soils. In these areas the depth of the gravel deposits ranges from about 4 feet to 15 feet or more.

This soil is used as woodland and as a source of gravel. The quality of the gravel is variable.

The major limitations to the use of this soil for crops are droughtiness, low natural fertility, slope, and susceptibility to soil blowing. Capability unit IVe-9 (4a-a); woodland suitability group 2s1; recreation group 3.

Eastport Series

The Eastport series consists of well drained or moderately well drained, nearly level or gently sloping soils on beach ridges and low dunes. The soils formed in sandy material.

In a representative profile the surface layer is black, partly decomposed leaf litter 3 inches thick. The subsurface layer is grayish-brown sand 4 inches thick. The upper part of the subsoil is dark-brown, loose sand 7 inches thick, and the lower part is brown, loose sand 8 inches thick. The underlying material is pale-brown sand.

Eastport soils have very low available water capacity and low natural fertility. Permeability is rapid. Runoff is slow.

These soils are used as woodland and for recreation. Several parks are located on these soils.

Representative profile of Eastport sand, 0 to 6 percent slopes, in a wooded area, in the N½SE¼SE¼ sec. 11, T. 38 N., R. 22 W., Delta County:

O1—3 inches to 0, black (10YR 2/1) partly decomposed leaf litter; very strongly acid; abrupt, smooth boundary.

A2—0 to 4 inches, grayish-brown (10YR 5/2) sand; single grained; loose; medium acid; clear, smooth boundary.

B2—4 to 11 inches, dark-brown (10YR 4/3) sand; single grained; loose; medium acid; gradual, smooth boundary.

B3—11 to 19 inches, brown (10YR 5/3) sand; single grained; loose; neutral; gradual, wavy boundary.

C —19 to 60 inches, pale-brown (10YR 6/3) sand; single grained; loose; slightly effervescent; mildly alkaline in upper part, becoming moderately alkaline with increasing depth.

The solum ranges from 15 to 36 inches in thickness but is dominantly 15 to 25 inches thick. The profile contains 2 to 5 percent gravel in some areas. Reaction of the solum ranges from medium acid to neutral.

A black (10YR 2/1) to very dark gray (10YR 3/1) A1 horizon, 1 to 3 inches thick, is present in some places. The A2 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2.

The B2 horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 8. Some weakly cemented chunks of ortstein are in the B2 horizon in places. The B3 horizon has hue of 10YR, value of 5 or 6, and chroma of 4 or 6.

The C horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 3 or 4. It is mildly alkaline or moderately alkaline in reaction. Mottles are present below a depth of 24 inches where the profile is moderately well drained.

Eastport soils are in positions similar to those of Alpena, East Lake, and Shelldrake soils. They lack the gravel in the C horizon that is typical of Alpena and East Lake soils. They are less acid in the lower part of the B and C horizons than Shelldrake soils.

Eastport sand, 0 to 6 percent slopes (EdB).—This soil is on beach ridges and low stabilized dunes near Lake Michigan. It has the profile described as representative of the series. The hazard of soil blowing is severe.

Included with this soil in mapping are a few areas of soils that have a darker brown subsoil and a few areas of soils that are more acid throughout than this Eastport soil. Also included are somewhat poorly drained Au Gres soils in swales in a few areas where this Eastport soil is adjacent to wetter soils; some isolated spots of East Lake soils; and many small areas where limestone bedrock is below a depth of about 4 to 8 feet.

This soil is used for recreation and as woodland. It has few limitations for summer cottage building sites. Some areas are adjacent to beaches. Care should be taken when placing septic systems in this very porous soil to prevent polluting wells.

The major limitations to the use of this soil are droughtiness, low natural fertility, and the hazard of soil blowing. Capability unit VIIs–1 (5.3a); woodland suitability group 2s3; recreation group 1.

Eastport-Roscommon sands, 0 to 6 percent slopes (EeB).—The complex consists of well drained and moderately well drained soils on beach ridges that alternate with poorly drained swales along Lake Michigan. Slopes range from 3 to 6 percent, but a few areas are more gently sloping and a few are steeper. The swales are 15 to 50 feet wide. The water table in the swales is near the surface most of the year.

Eastport soils are on the ridges. Eastport soils make up about 55 percent of this mapping unit. Roscommon soils are the dominant soils in the swales, and they make up about 45 percent of the mapping unit.

Included with these soils in mapping are small areas of somewhat poorly drained Au Gres and very poorly drained Tawas soils. In areas where this complex is near soils that have limestone bedrock, limestone bedrock is below a depth of 40 inches in swales. A few small areas of Alpena or East Lake soils are included on ridges. There is also an area of about 300 acres near Au Train, near Lake Superior. This area consists of moderately well drained, acid sand on beach ridges and of mainly Dawson soils in swales. Red pine and white birch are the main trees in this area. Leatherleaf grows in most of the swales.

The soils in this complex are used as woodland and, to a limited extent, for recreation. They are less suitable for cottage sites than Eastport sand, 0 to 6 percent slopes, because of the swales. Less suitable beaches are associated with this mapping unit than with Eastport sand, 0 to 6 percent slopes. Tree species common to both Eastport and Roscommon soils are in this mapping unit. More conifers grow on the Eastport part of this mapping unit than on Eastport sand, 0 to 6 percent slopes.

The major limitations to the use of the soils of this unit are complex topography, the hazard of soil blowing, and low natural fertility. Capability unit VIIs–1 (5.3a, 5c); woodland suitability group 2s3 for Eastport, 5w1 for Roscommon; recreation group 1.

Emmet Series

The Emmet series consists of well drained or moderately well drained, nearly level to sloping soils on till plains. These soils formed in loamy material.

In a representative profile the surface layer is very dark grayish-brown sandy loam about 9 inches thick. The subsurface layer is brown sandy loam about 1 inch thick. The upper part of the subsoil is dark-brown, friable fine sandy loam 8 inches thick. The middle part of the subsoil is reddish-brown, very friable sandy loam 8 inches thick. The lower part of the subsoil is reddish-brown, friable light sandy clay loam 7 inches thick. The underlying material is light yellowish-brown sandy loam. It contains small stones and rock fragments.

Emmet soils have moderate available water capacity and medium natural fertility. Permeability is moderate.

Emmet soils are used for hay, oats, and potatoes and as woodland.

Representative profile of Emmet sandy loam, 2 to 6 percent slopes, in a cultivated field, 100 feet southeast of the northwest corner of SW¼SE¼ sec. 21, T. 39 N., R. 24 W., Delta County:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, fine, granular structure; very friable; 2 percent coarse fragments; slightly acid; abrupt, smooth boundary.

A2—9 to 10 inches, brown (7.5YR 5/2) sandy loam; very weak, fine, granular structure; very friable; 2 percent coarse fragments; slightly acid; abrupt, broken boundary.

B2ir—10 to 18 inches, dark-brown (7.5YR 4/4) fine sandy loam; weak, coarse, subangular blocky structure; friable; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

A'2—18 to 26 inches, reddish-brown (5YR 5/3) sandy loam; weak, coarse, subangular blocky structure; very friable; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

B'2t—26 to 33 inches, reddish-brown (5YR 4/4) light sandy clay loam; weak, medium, subangular blocky structure; friable; few thin clay films on faces of peds; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

C—33 to 60 inches, light yellowish-brown (10YR 6/4) sandy loam; massive; friable; common small dolomitic stones and fragments; 3 percent coarse fragments; strongly effervescent; moderately alkaline.

The solum ranges from 24 to 45 inches in thickness. Reaction is medium acid to slightly acid in the A horizon and slightly acid to neutral in the B horizon.

In areas that have not been cultivated, the A1 horizon is very dark grayish-brown (10YR 3/2) and is 2 or 3 inches thick. The A2 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2. In plowed areas the A1 and A2 horizons are often mixed completely with the Ap horizon.

The B2ir horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4 or 6. It is sandy loam or fine sandy loam.

The A'2 horizon has hue of 5YR or 7.5YR, value of 5, and chroma of 2 or 3. It is sandy loam or loamy sand.

The B'2t horizon has hue of 5YR or 7.5YR and value and chroma of 4. It is loam or light sandy clay loam.

The C horizon has hue of 10YR to 5YR, value of 4 to 6, and chroma of 4. It commonly has lenses of loamy sand, ranging in thickness from a few inches to 6 to 12 inches, throughout the profile in places. The C horizon is stony in a few places.

Emmet soils are near Onaway and Longrie soils. They formed in coarser textured till than Onaway soils. They lack bedrock at a depth of 20 to 40 inches that is characteristic of Longrie soils.

Emmet sandy loam, 0 to 2 percent slopes (EmA).—This soil is on till plains. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few, small, depressional areas of somewhat poorly drained Charlevoix soils and areas of Blue Lake, Onaway, and Longrie soils. Also included are areas where the surface layer is loamy sand.

This soil is used for crops and as woodland.

Maintenance and improvement of organic-matter content help to improve the available moisture capacity and level of fertility. Random tiling in low spots is needed in places. Capability unit IIs–2 (3a); woodland suitability group 2o1; recreation group 4.

Emmet sandy loam, 2 to 6 percent slopes (EmB).—This soil is on till plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of Menominee, Onaway, and Longrie soils and some areas of soils that have a loamy sand surface layer. Also included are some moderately eroded areas where slopes are complex. In these areas the surface layer contains dark-brown material from the subsoil.

This soil is used for crops and as woodland. Practices to improve organic-matter content and to reduce the hazard of erosion are needed in some areas.

The major limitations to the use of this soil for crops are moderate droughtiness and the hazard of erosion. Capability unit IIe–3 (3a); woodland suitability group 2o1; recreation group 4.

Emmet sandy loam, 6 to 12 percent slopes (EmC).—This soil is on till plains. Some slopes are uniform, and some are short and complex. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are a few small areas of Menominee, Onaway, and Blue Lake soils. Moderate erosion has occurred on some of the short, complex slopes, and part of the dark-brown subsoil is mixed into the plow layer in these areas. Also included are a few areas of soils that have moderately steep slopes.

This soil is used for woodland and as cropland. It needs more intensive management to reduce erosion than is needed on the less sloping Emmet soils. This soil is slightly more droughty than the less sloping Emmet soils.

The major limitations to the use of this soil for crops are steepness and the hazard of erosion. Capability unit IIIe–6 (3a); woodland suitability group 2o1; recreation group 6.

Ensign Series

The Ensign series consists of somewhat poorly drained, nearly level or gently sloping soils on shallow till plains and bedrock benches. These soils formed in loamy material 10 to 20 inches thick over limestone bedrock.

In a representative profile the surface layer is very dark gray fine sandy loam 3 inches thick. The subsurface layer is grayish-brown fine sandy loam 3 inches thick. The upper part of the subsoil is mottled, yellowish-brown, friable loam 3 inches thick, and the lower part is mottled, brown, friable light loam 8 inches thick. Limestone bedrock is at a depth of 17 inches.

Ensign soils have moderate available water capacity. The shallow depth of the soil material results in droughtiness during extended dry periods. Natural fertility is medium. Permeability is moderate. The underlying limestone impedes downward movement of water in some areas, but in many areas it is cracked and fractured and does not impede downward movement of water. The seasonal high water table fluctuates from 1 to 2 feet below the surface to below the bedrock contact. Runoff is slow.

Ensign soils are used as woodland and for pasture. Many cleared areas are idle.

Representative profile of Ensign fine sandy loam, 0 to 3 percent slopes, in an uncultivated field, 30 feet northeast of the southwest corner of SE¼SW¼ sec. 25, T. 39 N., R. 22 W., Delta County:

A1—0 to 3 inches, very dark gray (10YR 3/1) fine sandy loam; weak, medium, granular structure; friable; less than 2 percent coarse fragments; mildly alkaline; abrupt, wavy boundary.

A2—3 to 6 inches, grayish-brown (10YR 5/2) fine sandy loam; weak, medium, subangular blocky structure; friable; many very dark gray (10YR 3/1) worm casts; 2 percent coarse fragments; mildly alkaline; clear, wavy boundary.

B21ir—6 to 9 inches, yellowish-brown (10YR 5/4) loam; common, fine, faint, yellowish-brown (10YR 5/6 and 5/8) mottles; weak, fine, subangular blocky structure; friable; 2 percent coarse fragments; slightly effervescent; mildly alkaline; clear, wavy boundary.

B22ir—9 to 17 inches, brown (7.5YR 5/4) light loam; common, fine, distinct, yellowish-brown (10YR 5/6 and 5/8) mottles; weak, medium, subangular blocky structure; friable; 3 percent coarse fragments; slightly effervescent; moderately alkaline; abrupt, smooth boundary.

IIR—17 inches, limestone bedrock.

The thickness of the solum and the depth to bedrock range from 10 to 20 inches. Some areas contain a high percentage of limestone flags throughout the profile. The reaction of the solum ranges from slightly acid to mildly alkaline in the upper part to moderately alkaline above the bedrock.

In cultivated areas is a very dark grayish-brown (10YR 3/2) to very dark brown (10YR 2/2) Ap horizon 6 to 8 inches thick. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1). The A2 horizon is light brownish gray (10YR 6/2) or grayish brown (10YR 5/2).

The B horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. In places there is a layer, 1 inch to 4 inches thick, directly above the bedrock, that appears to be residual material. In places a C horizon is present that has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4.

Ensign soils are near Ruse, Summerville, and Sundell soils. They have a browner subsoil than Ruse soils. They have mottles in the B horizon, which Summerville soils lack. They are shallower over bedrock than Sundell soils.

Ensign fine sandy loam, 0 to 3 percent slopes (En A).—This soil is on shallow till plains and limestone bedrock benches (fig. 7).

Included with this soil in mapping are a few small areas of Sundell soils and some stony areas. Also included are a few areas where slopes are as much as 6 percent.

This soil is used as woodland, is used for pasture, or is idle. Some of the cleared, idle areas are reverting to brush. Under good management this soil is suitable for forage crops.

The major limitations to the use of this soil are shallow soil depth and seasonal wetness. Capability unit VIIwc–2 (Rbc); woodland suitability group 3d1; recreation group 8.

Ensley Series

The Ensley series consists of poorly drained, nearly level or depressional soils on till plains. The soils formed in loamy material.

In a representative profile the surface layer is black muck 2 inches thick over 4 inches of black sandy loam. The upper part of the subsoil is grayish-brown, friable

Figure 7.—**Limestone benches. Ensign fine sandy loam, 0 to 3 percent slopes, is on the middle bench; Chatham fine sandy loam is on the upper bench; and Ruse silt loam is along the stream.**

fine sandy loam 6 inches thick; the next part is mottled, light brownish-gray, friable light sandy loam 4 inches thick; the next part is mottled, reddish-brown, friable light sandy clay loam 6 inches thick; and the lower part is reddish-brown, friable sandy loam 10 inches thick. The underlying material is reddish-brown sandy loam.

Ensley soils have moderate available water capacity and medium natural fertility. Permeability is moderate. Downward movement of water is impeded by the seasonal high water table, which is within 12 inches of the surface much of the year but drops to a depth of about 3 feet in some areas during dry periods. Runoff is very slow or ponded.

Ensley soils are used mainly as woodland.

Representative profile of Ensley sandy loam in an area of Ensley and Angelica soils, in a wooded area, in the SW¼SW¼SE¼ sec. 19, T. 43 N., R. 21 W., Delta County:

O2—2 inches to 0, black (10YR 2/1) muck; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A1—0 to 4 inches, black (10YR 2/1) sandy loam; moderate, coarse, granular structure; friable; slightly acid; abrupt, smooth boundary.

B21g—4 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam; weak, medium, platy structure; friable; less than 2 percent coarse fragments; slightly acid; clear, wavy boundary.

B22g—10 to 14 inches, light brownish-gray (10YR 6/2) light sandy loam; common, medium, distinct, strong-brown (7.5YR 5/6 and 5/8) mottles; moderate, medium, platy structure; friable; less than 2 percent coarse fragments; slightly acid; abrupt, wavy boundary.

B23—14 to 20 inches, reddish-brown (5YR 4/3) light sandy clay loam; many, medium, distinct, strong-brown (7.5YR 5/8) mottles; weak, thick, platy structure; friable; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

B3—20 to 30 inches, reddish-brown (5YR 5/4) sandy loam, blotches of olive yellow (2.5Y 6/8) around limestone pebbles; weak, medium, subangular blocky structure; friable; 2 percent coarse fragments; mildly alkaline; clear, wavy boundary.

C—30 to 60 inches, reddish-brown (5YR 5/3) sandy loam; massive; friable; 3 percent coarse fragments; slightly effervescent; mildly alkaline.

The solum ranges from 18 to 36 inches in thickness. Stones are common throughout the profile in a few areas. Reaction throughout the solum is slightly acid or neutral.

The O2 horizon has hue of 10YR or 5YR, value of 2, and chroma of 1. The A1 horizon has hue of 5YR or 10YR, value of 2 or 3, and chroma of 1.

The B21g horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam or fine sandy loam. The B22g horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. It is sandy loam or fine sandy loam. The B23 horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. It is heavy sandy loam to light sandy clay loam. The B3 horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4.

The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 or 4. Lenses of loamy sand are in the C horizon in some places.

Ensley soils are near Angelica, Charlevoix, and Nahma soils. They contain less clay at a depth of 10 to 40 inches than Angelica soils. They lack the brown in the upper part of the B horizon that is typical of Charlevoix soils. They do not have bedrock at a moderate depth, which is characteristic of Nahma soils.

Ensley and Angelica soils (0 to 2 percent slopes) (Es).—The soils in this mapping unit are poorly drained and are in nearly level or depressional areas on till plains. Ensley soils formed in sandy loam, and Angelica soils formed in loam. The surface layer is sandy loam or loam. Some areas are all Ensley soils, and some areas are all Angelica soils. Many areas are made up of both of these soils. In the northeastern part of the survey area, these soils have a profile that is more acid than that described as representative for the series.

Included with these soils in mapping are a few areas of very poorly drained Tacoosh and Cathro soils and some areas of Nahma soils. Also included are many areas that have limestone bedrock at a depth of about 4 to 10 feet and small knolls of somewhat poorly drained Charlevoix soils.

Most of the acreage of these soils is used as woodland. Some cleared areas are used for pasture, but some are idle and have reverted to alder trees. Drainage is needed for cultivated crops. Many areas lack adequate outlets for tile drains.

The major limitations to the use of these soils for crops are wetness and the hazard of frost. Capability unit IIwc–6 (3c, 2.5c); woodland suitability group 4w1; recreation group 10.

Fairport Series

The Fairport series consists of well drained or moderately well drained, nearly level or gently sloping soils on till plains. These soils formed in loamy material 20 to 40 inches thick over limestone bedrock.

In a representative profile the surface layer is dark-brown silt loam 7 inches thick. The subsurface layer is pinkish-gray silt loam 2 inches thick. The upper part of the subsoil is dominantly yellowish-red, firm silty clay loam 3 inches thick, and the lower part is reddish-brown, firm silty clay loam 13 inches thick. The underlying material, at a depth of 25 inches, is reddish-brown sandy clay loam 3 inches thick. Below this is limestone bedrock.

Fairport soils have high available water capacity and high natural fertility. Permeability is moderately slow.

Nearly all the acreage of Fairport soils is cleared and is used mainly for oats, hay, and pasture. The soils respond well to good management and are well suited to adapted crops.

Representative profile of Fairport silt loam, 0 to 2 percent slopes, in a cultivated field, in the NW¼NE¼NE¼ sec. 19, T. 39 N., R. 18 W., Delta County:

Ap—0 to 7 inches, dark-brown (7.5YR 3/2) silt loam; weak, medium, granular structure; friable; slightly acid; abrupt, irregular boundary.

A2—7 to 9 inches, pinkish-gray (7.5YR 6/2) silt loam; weak, medium, granular structure; friable; slightly acid; abrupt, irregular boundary.

B&A—9 to 12 inches, yellowish-red (5YR 4/8) silty clay loam (B); weak, medium, angular blocky structure; firm; 2 percent coarse fragments; medium acid; pinkish-gray (7.5YR 6/2) silt loam (A) in root channels, cracks, and as thick coatings on peds; clear, wavy boundary.

B21t—12 to 18 inches, reddish-brown (5YR 4/4) silty clay loam; moderate, medium, angular blocky structure; firm; thin clay films on faces of peds and in root channels; 2 percent coarse fragments; medium acid; clear, smooth boundary.

B22t—18 to 25 inches, reddish-brown (2.5YR 4/4) silty clay loam; moderate, coarse, angular blocky structure; firm; thin discontinuous clay films on faces of peds;

2 percent coarse fragments; neutral; abrupt, smooth boundary.

IIC—25 to 28 inches, reddish-brown (2.5YR 4/4) sandy clay loam; massive; firm; 2 percent coarse fragments; slightly effervescent; mildly alkaline; abrupt, smooth boundary.

IIIR—28 inches, limestone bedrock.

Depth to bedrock and thickness of the solum range from 20 to 40 inches but generally are about 24 to 30 inches. Reaction throughout the solum ranges from medium acid to mildly alkaline.

In undisturbed areas there is a very dark brown (10YR 2/2) A1 horizon 1 to 3 inches thick. In most profiles the A part of the B&A horizon consists of tongues that extend into the B part or of coatings on ped faces in the B part of the B&A horizon. The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2.

The B21t horizon has hue of 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam or silty clay loam. The B23t horizon has hue of 2.5YR, value of 4, and chroma of 3 or 4. It is clay loam or silty clay loam.

The IIC horizon has hue of 2.5YR, value of 4, and chroma of 4 or 5. It is sandy clay loam, clay loam, or silty clay loam.

Fairport soils are near Longrie and Nester soils. They are finer textured throughout the profile than Longrie soils. They have bedrock at a depth of 20 to 40 inches, and Nester soils have bedrock at a depth of more than 60 inches.

Fairport silt loam, 0 to 2 percent slopes (FaA).—This soil is on till plains. It has the profile described as representative of the series. Runoff is slow.

Included with this soil in mapping are small areas of Nester, Longrie, Summerville, and somewhat poorly drained Sundell soils. Also included are a few areas where the surface layer is stony.

Nearly all the acreage of this soil has been cleared and is used for hay, pasture, and oats. A few areas are used as woodland.

The main limitations to the use of this soil are wetness in spring, depth to bedrock, and soil structure. Management that maintains or improves organic-matter content, fertility, and soil structure is needed. Capability unit IIIs–2 (2/Ra); woodland suitability group 2o3; recreation group 5.

Fairport silt loam, 2 to 6 percent slopes (FaB).—This soil is on till plains. Runoff generally is slow but increases to medium on the stronger slopes. Included in mapping are a few small areas of Nester, Longrie, and Summerville soils.

This soil is well suited to all crops commonly grown in the survey area. It is used for hay, pasture, and oats. A few areas are used as woodland.

The major limitations to the use of this soil are depth to bedrock and soil structure. Management that maintains or improves organic-matter content, fertility, and soil structure is needed. Capability unit IIIe–8 (2/Ra); woodland suitability group 2o3; recreation group 5.

Gilchrist Series

The Gilchrist series consists of nearly level or gently sloping, well drained and moderately well drained soils on till plains. These soils formed in 20 to 40 inches of sandy material over loamy material.

In a representative profile the surface layer is black leaf litter and mineral soil 2 inches thick. The subsurface layer is pinkish-gray sand 5 inches thick. The upper part of the subsoil is dark reddish-brown, very friable sand 5 inches thick; the next part is reddish-brown, very friable sand 8 inches thick; the next part is strong-brown loose sand 8 inches thick; and the lower part is light-brown, loose sand 4 inches thick. The underlying material is at a depth of 30 inches. It is light-brown sandy loam that contains many limestone fragments.

Gilchrist soils have low available water capacity in the sandy layers and moderate available water capacity in the underlying material. Natural fertility is low. Permeability is rapid in the sandy layers and moderate in the underlying material. Runoff is slow.

Gilchrist soils are used as woodland and for hay and pasture.

Representative profile of Gilchrist sand, 0 to 6 percent slopes, in a wooded area, in the NE¼NE¼NW¼ sec. 14, T. 41 N., R. 17 W., Schoolcraft County:

O1—2 inches to 0, black (10YR 2/1) well-decomposed leaf litter that has a high percentage of mineral soil; weak, medium, granular structure; very friable; many fine roots; very strongly acid; abrupt, smooth boundary.

A2—0 to 5 inches, pinkish-gray (5YR 6/2) sand; weak, very coarse, granular structure; very friable; strongly acid; abrupt, wavy boundary.

B21hir—5 to 10 inches, dark reddish-brown (5YR 3/3) sand; very weak, medium, granular structure; very friable; slightly acid; clear, wavy boundary.

B22ir—10 to 18 inches, reddish-brown (5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; contains a few weakly cemented chunks of ortstein; slightly acid; gradual, wavy boundary.

B23ir—18 to 26 inches, strong-brown (7.5YR 5/6) sand; single grained; loose; neutral; abrupt, wavy boundary.

B3—26 to 30 inches, light-brown (7.5YR 6/4) sand; single grained; loose; mildly alkaline; clear, wavy boundary.

IIC—30 to 60 inches, light-brown (7.5YR 6/4) sandy loam; massive; friable; contains many limestone fragments; 2 percent coarse fragments; slightly effervescent; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness but is commonly 24 to 36 inches thick. It corresponds to the thickness of the sandy material. Reaction of the solum ranges from strongly acid to slightly acid in the upper part of the solum and from slightly acid to mildly alkaline in the lower part.

In a few places there is a very dark gray (N 3/0) A1 horizon 1 to 2 inches thick. In cultivated areas the Ap horizon is 6 to 9 inches thick and is very dark grayish brown. The A2 horizon is pinkish gray (5YR 6/2 or 7.5YR 6/2).

The B21hir horizon is dark reddish-brown (5YR 2/2 or 3/3) sand or loamy sand. The B22ir horizon has hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 4 or 6. It is sand or loamy sand. The B23ir horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 or 6. It is sand or loamy sand. The B3 horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 4 or 6.

The IIC horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 or 4. It is sandy loam or stony sandy loam.

Gilchrist soils are near Menominee and Kalkaska soils. They have a coarser textured C horizon than Menominee soils, and they lack the A′ & B′ horizon that is characteristic of Menominee soils. They have a sandy loam C horizon, which Kalkaska soils lack.

Gilchrist sand, 0 to 6 percent slopes (GcB).—This soil is on till plains. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of Menominee, Kalkaska, and Duel soils. In Schoolcraft County some areas are included where the sandy horizons are only about 15 inches thick. In Alger County the underlying material is generally more stony and is less alkaline than that in Schoolcraft County.

Cleared areas of this soil are used for hay and pasture or are idle.

The major limitations to the use of this soil for crops are droughtiness and low natural fertility. Capability unit IIIs–4 (4a); woodland suitability group 2s1; recreation group 2.

Grayling Series

The Grayling series consists of well-drained, nearly level to moderately steep soils on lake plains. These soils formed in sandy material.

In a representative profile the surface layer is black and grayish-brown sand 3 inches thick. The upper part of the subsoil is dark-brown, very friable sand 6 inches thick; the middle part is strong-brown, very friable to loose sand 6 inches thick; and the lower part is brown, loose sand 8 inches thick. The underlying material is light-brown sand.

Grayling soils have very low available water capacity and low natural fertility. Permeability is very rapid. Runoff is slow or very slow.

These soils are used as woodland.

Representative profile of Grayling sand, 0 to 6 percent slopes, in a wooded area, in the SW¼SW¼SE¼SW¼ sec. 34, T. 41 N., R. 21 W., Delta County:

A1&A2—0 to 3 inches, black (N 2/0) sand (A1) and grayish-brown (10YR 5/2) sand (A2); coated and uncoated sand grains mixed throughout the horizon, giving a salt and pepper appearance; moderate organic-matter content in upper part; weak, medium, granular structure; very friable; very strongly acid; abrupt, smooth boundary.

B21ir—3 to 9 inches, dark-brown (7.5YR 4/4) sand; weak, coarse; granular structure; very friable; strongly acid; clear, smooth boundary.

B22ir—9 to 15 inches, strong-brown (7.5YR 5/6) sand; very weak, coarse, granular structure parting to single grained; very friable to loose; medium acid; clear, irregular boundary.

B3—15 to 23 inches, brown (7.5YR 5/4) sand; single grained; loose; medium acid; gradual, smooth boundary.

C—23 to 60 inches, light-brown (7.5YR 6/4) sand; single grained; loose; medium acid.

The solum ranges from 15 to 30 inches in thickness, but it is most commonly 15 to 24 inches thick. Reaction of the solum ranges from very strongly acid to medium acid.

An O1 horizon, ½ to 1 inch thick, is on the surface in some areas. The surface horizon is commonly an A1 horizon or a combined A1 and A2 horizon. An A3 horizon is present in a few places. The A1 horizon is black (7.5YR 2/1, 10YR 2/1, or N 2/0). The A2 material is grayish brown (10YR 5/2) or light grayish brown (10YR 6/2).

The B22ir horizon is strong brown (7.5YR 5/6) or reddish yellow (7.5YR 6/6).

The C horizon has hue of 5YR and 7.5YR, value of 5 to 7, and chroma of 4 or 6. It is medium acid or slightly acid in reaction.

Grayling soils are near Croswell and Rubicon soils. They lack mottling in the C horizon, which is characteristic of the Croswell soils. They lack the distinct A2 horizon that is typical of Rubicon soils.

Grayling sand, 0 to 6 percent slopes (GrB).—This soil is on lake plains. It has the profile described as representative of the series. Runoff is very slow, and the hazard of soil blowing is severe.

Included with this soil in mapping are a few areas of moderately well drained Croswell soils in small depressions. Also included are some areas of Rubicon soils.

This soil is used mostly as woodland. The use of this soil is severely limited by low natural fertility, droughtiness, and the hazard of soil blowing. Capability unit VIIs-1 (5.7a); woodland suitability group 4s1; recreation group 1.

Grayling sand, 6 to 18 percent slopes (GrD).—This soil is on lake plains. Runoff is slow or very slow. The hazard of soil blowing is severe, and the hazard of water erosion is slight. Included in mapping are a few small areas of Rubicon soils.

This soil is used as woodland.

The use of this soil is severely limited by droughtiness, low fertility, and the hazard of soil blowing. Capability unit VIIs–1 (5.7a); woodland suitability group 4s1; recreation group 3.

Greenwood Series

The Greenwood series consists of very poorly drained, nearly level or depressional soils in bogs on lake plains and outwash plains. These soils formed in extremely acid, mainly herbaceous organic material.

In a representative profile the surface layer is yellowish-brown peat (fibric material) 4 inches thick. The next layer is very dark grayish-brown peat (fibric material) 3 inches thick. The next layer is dark-brown peat (fibric material) 3 inches thick. The lower layers are dark reddish-brown mucky peat (hemic material) that extends to a depth of 62 inches.

Greenwood soils have very high available water capacity and low natural fertility. Permeability is rapid. Downward movement of water is impeded by the water table, which is at the surface most of the year but may drop to a depth of 2 feet late in summer in some areas. Runoff is very slow or ponded.

Greenwood soils are used for wildlife habitat. The extreme acidity and poor aeration of these soils in most areas limit tree species to a few slow-growing black spruce. Most areas of these soils are open bog covered with sphagnum moss, leatherleaf, and bog rosemary.

Representative profile of Greenwood peat, in an open bog, in the NE¼SW¼SW¼ sec. 10, T. 43 N., R. 20 W., Delta County:

Oi1—0 to 4 inches, yellowish-brown (10YR 5/4) and light yellowish-brown (10YR 6/4 rubbed and pressed) fibric material; 100 percent fiber, 100 percent rubbed; massive; nonsticky; fibers are sphagnum moss; extremely acid; clear, smooth boundary.

Oi2—4 to 7 inches, very dark grayish-brown (10YR 3/2) and dark grayish-brown (10YR 4/2, rubbed and pressed) fibric material; about 95 percent fiber, 90 percent rubbed; massive; nonsticky; fibers are sphagnum moss; extremely acid; clear, smooth boundary.

Oi3—7 to 10 inches, dark-brown (7.5YR 3/2, broken face, rubbed and pressed) fibric material; about 75 percent fiber, 55 percent rubbed; massive; nonsticky; fibers are sphagnum moss; extremely acid; clear, smooth boundary.

Oe1—10 to 16 inches, dark reddish-brown (5YR 3/3) and dark-brown (7.5YR 3/2, rubbed and pressed) hemic material; about 55 percent fiber, 35 percent rubbed; massive; nonsticky; fibers are herbaceous; extremely acid; gradual, smooth boundary.

Oe2—16 to 62 inches, dark reddish-brown (5YR 3/3) and dark-brown (7.5YR 3/2, rubbed and pressed) hemic material; about 67 percent fiber, 37 percent rubbed; massive; nonsticky; fibers are herbaceous; extremely acid.

The organic material is more than 51 inches thick. Woody fragments in the form of stumps, roots, and twigs are common. Colors of the broken face vary widely, depending on the degree of decomposition. All layers include hue of 5YR to 10YR, value of 2 to 5, and chroma of 2 to 4. Reaction is extremely acid or very strongly acid.

The surface tier is fibric or hemic material. It most commonly is fibric material that is mainly sphagnum moss in the upper several inches.

The subsurface tier and the bottom tier are dominantly hemic material of herbaceous origin. Layers of sapric or fibrous material are commonly present, but they make up less than one-third by volume of the subsurface and bottom tiers.

Greenwood soils are near Dawson, Carbondale, Lupton, and Rifle soils. They are deeper over mineral soil material than Dawson soils. They are more acid than Carbondale, Lupton, and Rifle soils.

Greenwood peat (0 to 2 percent slopes) (Gw).—This nearly level or depressional soil is on lake plains and outwash plains.

Included with this soil in mapping are a few areas of Dawson soils near the edges of areas of this soil. Also included are areas where the thickness of the organic material ranges from 4½ feet to more than 15 feet.

This soil is used for wildlife habitat. Most areas of this soil support a few trees. Leatherleaf, sphagnum moss, bog rosemary, and labrador tea make up most of the plant cover. A few cranberries and blueberries are present in some areas. Scattered black spruce, jack pine, and white pine grow in some areas, and some areas support stands of bog birch, tamarack, and black spruce. Most trees generally are around the edges of areas of this soil near the adjacent uplands. Trees grow very slowly.

This soil has very slow drainage laterally through the organic material because of restricted outlets. It has severe limitations for crops because of the year-round high water table, extreme acidity, and hazard of frost. Capability unit VIIIwc–1 (Mc–a); woodland suitability group not assigned; recreation group 11.

Iosco Series

The Iosco series consists of somewhat poorly drained, nearly level or gently sloping soils on lake plains and till plains. These soils formed in sandy material, 20 to 40 inches thick, and in the underlying loamy material.

In a representative profile the surface layer is black, partly decomposed leaf litter 3 inches thick. The subsurface layer is pinkish-gray sand 12 inches thick. The upper part of the subsoil is mottled, dark reddish-brown, very friable sand 3 inches thick; the next part is mottled, dark-brown, very friable sand 7 inches thick; the next part is mottled, strong-brown, very friable sand 7 inches thick; and the lower part is mottled, reddish-brown, firm light clay loam 3 inches thick. The underlying material begins at a depth of 32 inches. It is mottled, reddish-brown loam that contains many cobblestones and stones.

Iosco soils have low available water capacity in the sandy layers and high available water capacity in the underlying material. Natural fertility is low. Permeability is rapid in the sandy layers and moderately slow in the underlying material. The seasonal high water table fluctuates between depths of about 1 and 2 feet. Runoff is slow.

599–811—77——4

Small areas of these soils have been cleared and are used for hay and pasture. Most of the areas are used as woodland.

Representative profile of Iosco sand, 0 to 6 percent slopes, in a wooded area, in the NW¼NE¼NW¼ sec. 2, T. 40 N., R. 18 W., Delta County:

O1—3 inches to 0, black (5YR 2/1) partly decomposed leaf litter.

A2—0 to 12 inches, pinkish-gray (7.5YR 6/2) sand; very weak, coarse, subangular blocky structure; very friable; very strongly acid; abrupt, irregular boundary.

B21ir—12 to 15 inches, dark reddish-brown (5YR 3/2) sand; few, fine, faint yellowish-red (5YR 4/6) mottles; massive; very friable; very strongly acid; abrupt, wavy boundary.

B22ir—15 to 22 inches, dark-brown (7.5YR 4/4) sand; many, medium and coarse, distinct, dark reddish-brown (5YR 3/4) and yellowish-red (5YR 5/6) mottles; massive; very friable; strongly acid; abrupt, wavy boundary.

B3—22 to 29 inches, strong-brown (7.5YR 5/6) sand; many, medium, distinct, yellowish-red (5YR 5/6) and pinkish-gray (7.5YR 6/2) mottles; very weak, medium, subangular blocky structure; very friable; strongly acid; abrupt, smooth boundary.

IIB'2t—29 to 32 inches, reddish-brown (5YR 5/4) light clay loam; many, fine, faint, yellowish-red (5YR 5/6) mottles; weak, medium, subangular blocky structure; firm; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

IIC—32 to 60 inches, reddish-brown (5YR 5/3) loam; few, medium, distinct, reddish-yellow (7.5YR 6/8) mottles in the upper part; massive; friable; numerous cobblestones and stones; 3 percent coarse fragments; strongly effervescent; moderately alkaline.

The solum ranges from 24 to 50 inches in thickness. Reaction ranges from very strongly acid to slightly acid in the sandy part of the solum and from slightly acid to mildly alkaline in the loamy part. Depth to the loamy material ranges from 20 to 40 inches, but it is most commonly about 20 to 30 inches.

The O1 horizon is black (5YR 2/1). A dark-brown (7.5YR 3/2) Ap horizon 6 to 8 inches thick is present in cultivated areas. The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2.

The B21ir horizon is dark reddish-brown (5YR 3/2 to 3/4) sand or loamy sand. The B22ir horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4 or 6. It is sand or loamy sand. The B3 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 or 6. It is sand or loamy sand. Consistence and structure of the sandy upper layers range from very friable and weak, subangular blocky or massive, to loose and single grained.

The IIB'2t horizon is reddish-brown (5YR 4/4 to 5/4) light clay loam to heavy loam. The IIC horizon has hue of 5YR or 7.5YR, value of 5, and chroma of 3 or 4. It ranges from loam to silty clay.

Iosco soils are near Au Gres and Menominee soils. They have loamy material within a depth of 40 inches, which Au Gres soils lack. They have mottles in the upper part of the B horizon, which Menominee soils lack.

Iosco sand, 0 to 6 percent slopes (IoB).—This soil is on till plains. Slopes are dominantly about 1 to 4 percent.

Included with this soil in mapping are a few depressional areas and waterways that contain poorly drained Brevort soils, and a few areas where the surface layer is loamy sand. Also included are areas on the Stonington Peninsula where the underlying material is less stony and more stratified than in other areas.

Most areas of this soil are used as woodland. A small acreage has been cleared and is used for hay or pasture. Drainage is needed for cultivated crops. Not all areas have adequate outlets for tile. Tile is difficult to install, because the soil is susceptible to caving.

Major limitations to the use of this soil for crops are seasonal wetness, low natural fertility, slight hazard of frost, and susceptibility to soil blowing if the soil is exposed. Capability unit IIIwc–9 (4/2b); woodland suitability group 3s3; recreation group 8.

Kalkaska Series

The Kalkaska series consists of well drained or moderately well drained, nearly level to very steep soils on outwash plains, till plains, and moraines. These soils formed in sandy material.

In a representative profile the surface layer is black, partly decomposed forest litter 2 inches thick. The subsurface layer is pinkish-gray sand 10 inches thick. The upper part of the subsoil is dark reddish-brown, friable sand 3 inches thick; the middle part is dark reddish-brown, loose sand 4 inches thick; and the lower part is strong-brown, loose sand 10 inches thick. The underlying material is light-brown sand.

Kalkaska soils have very low available water capacity and low natural fertility. Permeability is rapid.

These soils are sandy and droughty, and only a very small acreage is used for crops. Most of the areas that were cleared are idle or have been planted to red pine. Nearly all the areas are used as woodland.

Representative profile of Kalkaska sand, 0 to 6 percent slopes, in a wooded area, in the NE¼SE¼NE¼ sec. 35, T. 43 N., R. 19 W., Delta County:

O2—2 inches to 0, black (5YR 2/1) partly decomposed organic litter; very strongly acid; abrupt smooth boundary.

A2—0 to 10 inches, pinkish-gray (5YR 6/2) sand; weak, fine granular structure; very friable; medium acid; abrupt, wavy boundary.

B21hir—10 to 13 inches, dark reddish-brown (5YR 2/2) sand; weak, fine, granular structure; friable; very strongly acid; clear, wavy boundary.

B22ir—13 to 17 inches, dark reddish-brown (5YR 3/4) sand; single grained; loose; medium acid; gradual, smooth boundary.

B3—17 to 27 inches, strong-brown (7.5YR 5/6) sand; single grained; loose; medium, acid; clear, smooth boundary.

C—27 to 60 inches, light-brown (7.5YR 6/4) sand; single grained; loose; medium acid.

The solum ranges from 24 to 48 inches in thickness, but most commonly it is 24 to 36 inches thick. Reaction of the solum ranges from very strongly acid to medium acid.

In cultivated areas plowing has mixed the O2 and A2 horizons to form an Ap horizon 5 to 8 inches in thickness. The Ap horizon ranges from dark gray to very dark gray (10YR 4/1 to 3/1). Both an O1 horizon and an O2 horizon are present in a few places.

A black (10YR 2/1) A1 horizon 1 to 2 inches thick is present in a few places. The A2 horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 1 or 2. Its boundary is irregular, and it has tongues that extend downward as much as 44 inches.

The B21hir horizon has hue of 5YR, value of 2 or 3, and chroma of 2 or 3. Its boundary is wavy to irregular; and it has tongues that extend to a depth of 46 inches in some places (fig. 8). The B22ir horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 4 to 8. Distinctness of the B22ir boundary ranges from clear to diffuse. The color of the B3 horizon is transitional from the B22ir horizon to the C horizon.

The C horizon has hue of 5YR or 7.5YR, value of 5 to 7, and chroma of 4 or 6. It is medium acid or slightly acid in reaction. The C horizon is mottled in areas that are moderately well drained.

Kalkaska soils are near Blue Lake, Karlin, and Rubicon soils. They lack the loamy A′&B′ horizon that is characteristic of Blue Lake soils. They have coarser textured A and B horizons than Karlin soils. They are darker brown in the upper part of the B horizon than Rubicon soils.

Figure 8.—**Profile of a Kalkaska sand, showing characteristic tonguing of subsurface layer and subsoil.**

Kalkaska sand, 0 to 6 percent slopes (KaB).—This soil is on outwash plains, till plains, and moraines. It has the profile described as representative of the series. Runoff is slow or very slow. Soil blowing is a hazard if the soil is exposed.

Included with this soil in mapping are a few areas of Blue Lake and Rubicon soils and some areas of soils that have a surface layer of loamy sand. Also included are some spots of soils that have a discontinuously cemented subsoil. There are some areas, bordering swamps or waterways, where the soils are mottled in the underlying material.

Most of this soil is used as woodland (fig. 9). Most cleared areas are idle or have been replanted to pine.

The major limitations to the use of this soil for crops are droughtiness, low natural fertility, and the hazard of soil blowing. Capability unit IVs–4 (5a); woodland suitability group 3s1; recreation group 1.

Kalkaska sand, 6 to 18 percent slopes (KaD).—This soil is on moraines, outwash plains, and till plains. Runoff is slow. The hazard of erosion is severe.

Included with this soil in mapping are areas of Rubicon, Karlin, and Blue Lake soils and some areas of Kalkaska sand that has slopes less than 6 percent and more than 18 percent. Also included are some areas of soils that have a surface layer of loamy sand and a few small areas, in southwestern Delta County, where the underlying material is gravelly.

This soil is used as woodland.

The major limitations to the use of this soil for crops are low natural fertility, droughtiness, steepness, and the hazard of erosion. Capability unit VIs–1 (5a); woodland suitability group 3s1; recreation group 3.

Figure 9.—Second growth of maple trees in an area of Kalkaska sand. The potential productivity of this soil for hardwoods is low to medium.

Kalkaska sand, 18 to 40 percent slopes (KaE).—This soil is on moraines and outwash plains. Runoff is slow because the soil is rapidly permeable. The hazard of erosion is severe.

Included with this soil in mapping are areas of Blue Lake, Karlin, Rousseau, and Steuben soils. Also included are a few areas of soils that have a cemented subsoil.

This soil is used as woodland.

The major limitations to the use of this soil are steepness, low natural fertility, and the hazard of erosion. Capability unit VIIs–1 (5a); woodland suitability group 3s2; recreation group 7.

Karlin Series

The Karlin series consists of well-drained, nearly level to moderately steep soils on outwash plains, till plains, and moraines. These soils formed in dominantly loamy material 15 to 40 inches thick over sandy material.

In a representative profile the surface layer is black, partly decomposed leaf litter 2 inches thick. The subsurface layer is brown sandy loam 4 inches thick. The upper part of the subsoil is dark reddish-brown, friable sandy loam 3 inches thick, the middle part is reddish-brown, very friable sandy loam 10 inches thick, and the lower part is dark-brown, very friable loamy sand 5 inches thick. The underlying material is brown sand that extends to a depth of 60 inches or more.

Karlin soils have moderate available water capacity in the loamy layers and very low available water capacity in the underlying material. Natural fertility is medium. Permeability is moderately rapid.

Most areas of these soils are used as woodland. Much of the acreage that has been cleared is idle. Areas under cultivation are used for small grain, potatoes, hay, and pasture.

Representative profile of Karlin sandy loam, 0 to 6 percent slopes, in a wooded area, in the NE¼SE¼SE¼ NW¼ sec. 15, T. 40 N., R. 21 W., Delta County:

O1—2 inches to 0, black (5YR 2/1) partly decomposed leaf litter; strongly acid; abrupt, smooth boundary.

A2—0 to 4 inches, brown (7.5YR 5/2) sandy loam; weak, medium, granular structure; very friable; strongly acid; abrupt, wavy boundary.

B21ir—4 to 7 inches, dark reddish-brown (5YR 3/3) sandy loam; weak, fine, subangular blocky structure; friable; strongly acid; abrupt, wavy boundary.

B22ir—7 to 17 inches, reddish-brown (5YR 4/4) sandy loam; weak, fine, granular structure; very friable; medium acid; gradual, wavy boundary.

B3—17 to 22 inches, dark-brown (7.5YR 4/4) loamy sand; very weak, medium, granular structure; very friable; medium acid; abrupt, smooth boundary.

IIC—22 to 60 inches, brown (7.5YR 5/4) sand; single grained; loose; medium acid.

The solum ranges from 15 to 40 inches in thickness, but it is most commonly 16 to 30 inches thick. Reaction throughout the solum ranges from very strongly acid to medium acid.

An A1 horizon 1 to 2 inches thick is present in some places. It has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The A2 horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 1 or 2. In cultivated areas the A1 and A2 horizons generally are completely mixed to form a very dark gray (10YR 3/1) plow layer.

The B21ir horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 8. It is sandy loam, fine sandy loam, or loamy fine sand. The B3 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 or 6. It is loamy sand or loamy fine sand.

The IIC horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4. It is medium acid or slightly acid in reaction. A few cobblestones are in the IIC horizon in some places.

Karlin soils are near Blue Lake, Kalkaska, and Steuben soils. They have finer textured A and B horizons than Blue Lake and Kalkaska soils, and they lack the A′ & B′ horizon that is characteristic of Blue Lake soils. They lack the fragipan in the lower part of the B horizon that is typical of Steuben soils.

Karlin sandy loam, 0 to 6 percent slopes (KdB).—This soil is on outwash plains, till plains, and moraines. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of Blue Lake and Kalkaska soils. Also included, in Schoolcraft County, are areas of Trenary soils.

Most areas of this soil are used as woodland. Hay, small grain, and pasture are the main crops. Some idle areas have been planted to pine.

The major limitation to the use of this soil for crops is droughtiness. Capability unit IIIs–4 (4a); woodland suitability group 2s1; recreation group 4.

Karlin sandy loam, 6 to 18 percent slopes (KdD).—This soil is on moraines and till plains. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping are areas of Kalkaska and Blue Lake soils. Also included are areas of Trenary soils, in Schoolcraft County; areas where the surface layer is loamy sand or fine sandy loam; and some areas where the slopes are more than 18 percent.

Nearly all areas of this soil are used as woodland.

The major limitations to the use of this soil for crops are steepness, droughtiness, and the hazard of erosion. Capability unit IVe–9 (4a); woodland suitability group 2s1; recreation group 6.

Kawbawgam Series

The Kawbawgam series consists of somewhat poorly drained, nearly level to sloping soils on sandstone benches. These soils formed in loamy material 20 to 40 inches thick over sandstone bedrock.

In a representative profile the surface layer is dark reddish-brown, well-decomposed leaf litter, 2 inches thick, that contains a high percentage of mineral soil. The subsurface layer is brown sandy loam 6 inches thick. The upper part of the subsoil is mottled, dark reddish-brown, friable sandy loam 4 inches thick and, the lower part is mottled, brown, friable sandy loam 8 inches thick. The underlying material is mottled, brown light sandy loam 6 inches thick. At a depth of 24 inches is pinkish-white and reddish-brown sandstone that is highly weathered and soft in the upper 6 inches.

Kawbawgam soils have moderate available water capacity and medium natural fertility. Permeability is moderate. Downward movement of water is impeded by the bedrock. The seasonal high water table is within a depth of 1 to 2 feet in spring but drops to below the bedrock contact during summer months. Runoff is slow.

Kawbawgam soils are used as woodland. They are in such small, scattered, and isolated areas that they are unimportant in farming.

Representative profile of Kawbawgam sandy loam, 0 to 10 percent slopes, in a wooded area, in the NE¼SE¼SE¼ sec. 28, T. 47 N., R. 20 W., Alger County:

O2 –2 inches to 0, dark reddish-brown (5YR 2/2), well-decomposed leaf litter that has a high percentage of mineral soil; many roots; weak, fine, granular structure; very friable; very strongly acid; abrupt, smooth boundary.

A2—0 to 6 inches, brown (7.5YR 5/2) sandy loam; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; very strongly acid; abrupt, wavy boundary.

B21hir—6 to 10 inches, dark reddish-brown (5YR 3/3) sandy loam; many, medium, faint, dark reddish-brown (5YR 3/4) mottles; weak, very coarse, subangular blocky structure; friable; less than 2 percent coarse fragments; very strongly acid; clear, wavy boundary.

B22ir—10 to 18 inches, brown (7.5YR 4/2) sandy loam; many, medium, distinct, dark-brown (7.5YR 4/4) and strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; strongly acid; clear, wavy boundary.

C—18 to 24 inches, brown (7.5YR 5/4) light sandy loam; common, medium, faint, strong-brown (7.5YR 5/6) mottles; massive; friable; less than 2 percent coarse fragments; strongly acid; gradual, wavy boundary.

IIR—24 inches, pinkish-white (7.5YR 8/2) and reddish-brown (2.5YR 5/4) strongly acid sandstone bedrock; soft in the upper 6 inches.

The solum ranges from 16 to 36 inches in thickness. Depth to bedrock ranges from 20 to 40 inches. Reaction of the solum is very strongly acid or strongly acid in the upper part and strongly acid or medium acid in the lower part.

In some places a black (5YR 2/1 or 10YR 2/1) or very dark grayish-brown (10YR 3/2) A1 horizon 1 to 3 inches thick is present. The A2 horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 2.

The B21hir horizon is dark reddish brown (5YR 3/2, 3/3, or 3/4). The B22ir horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6.

The C horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is strongly acid to medium acid. The upper few inches of the sandstone IIR horizon generally is weathered and soft, but it becomes harder as depth increases.

Kawbawgam soils are near Deerton and Onota soils. They are finer textured than Deerton soils and have a mottled B horizon, which Deerton and Onota soils lack.

Kawbawgam sandy loam, 0 to 10 percent slopes (KgC).—This soil is in seepy areas on sandstone bedrock benches. Seepage along bedrock under higher adjacent soils causes this soil to be wet. In some areas the sandstone is soft and highly weathered. Bands and strata of loamy sand are common in this soil. Slopes dominantly range from 0 to 6 percent but are as much as 10 percent.

Included with this soil in mapping are a few areas of poorly drained Burt soils in depressions. Also included in higher areas are moderately well drained Onota or Munising soils.

This soil is used as woodland. It cannot be adequately drained with tile, because it is shallow over bedrock.

The major limitations to the use of this soil for crops are seasonal wetness, depth to bedrock, and the hazard of

frost. Capability unit IIIwc–4 (3/Rbc); woodland suitability group 2o5; recreation group 8.

Kawkawlin Series

The Kawkawlin series consists of somewhat poorly drained, nearly level soils on till plains. These soils formed in loamy material.

In a representative profile the surface layer is very dark grayish-brown silt loam 9 inches thick. The subsurface layer is mottled, light brownish-gray silt loam 1 inch thick. The subsoil is mottled, reddish-brown, firm heavy clay loam 11 inches thick. The upper part of the subsoil has tongues and streaks of light brownish-gray silt loam. The underlying material is mottled, reddish-brown clay loam that extends to a depth of 60 inches or more.

Kawkawlin soils have high available water capacity and high natural fertility. Permeability is moderately slow. These soils are excessively wet in spring. The seasonal high water table fluctuates between depths of about 1 and 2 feet. Water stands on the surface for short periods after heavy rains. Runoff is slow.

Nearly all areas of these soils are used for hay or are idle.

Representative profile of Kawkawlin silt loam, 0 to 2 percent slopes, in a cultivated field, south of Garden Creek in the NE¼SE¼NE¼ sec. 21, T. 39 N., R. 18 W., Delta County:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, coarse, granular structure; friable; neutral; abrupt, smooth boundary.

A2—9 to 10 inches, light brownish-gray (10YR 6/2) silt loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, coarse, granular structure; friable; neutral; abrupt, broken boundary.

B&A—10 to 13 inches, reddish-brown (2.5YR 4/4) heavy clay loam; nearly surrounded by light brownish-gray (10YR 6/2) silt loam; few, medium, distinct, strong-brown (7.5YR 5/6) and grayish-brown (10YR 5/2) mottles; moderate, fine, subangular blocky structure; firm; 2 percent coarse fragments; neutral; gradual, wavy boundary.

B2t—13 to 21 inches, reddish-brown (2.5YR 4/4) heavy clay loam; common, medium, distinct, yellowish-red (5YR 5/6) mottles; few tongues of pale-brown (10YR 6/3) A2 material mottled with grayish brown (10YR 5/2) in upper part; moderate, fine, angular blocky structure; firm; 2 percent coarse fragments; mildly alkaline; gradual, wavy boundary.

C—21 to 60 inches, reddish-brown (2.5YR 5/4) clay loam; common, medium, distinct, yellowish-red (5YR 5/6) mottles in the upper 6 inches; weak, medium, subangular blocky structure; firm; 2 percent coarse fragments; slightly effervescent; moderately alkaline.

The solum ranges from 20 to 26 inches in thickness. Reaction throughout the solum ranges from slightly acid to mildly alkaline.

The Ap horizon has hue of 5YR to 10YR, value of 3, and chroma of 1 or 2. The A2 horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2.

The B part of the B&A horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2. The A part of the B&A horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4.

The B2t horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam or silty clay loam.

The C horizon has hue of 2.5YR to 7.5YR, value of 5, and chroma of 3 or 4. It is clay loam or silty clay loam.

Kawkawlin soils are near Bowers and Nester soils. They are less stratified than Bowers soils because they formed in till material rather than in lacustrine material. They have a mottled B horizon, which Nester soils lack.

Kawkawlin silt loam, 0 to 2 percent slopes (KlA).—This soil is on till plains.

Included with this soil in mapping are a few small areas of Sundell soils and moderately well drained Nester soils. Also included are some areas where limestone bedrock is at a depth of about 4 to 6 feet.

Nearly all of the acreage of this soil is used for hay or is idle. Part of it is planted to spruce. The major limitations to the use of this soil for crops are excessive seasonal wetness and poor tilth. Tiling is not always practical, because tile lines must run through adjacent soils where bedrock is at a depth of less than 3 feet. Management that maintains soil structure is important on this soil. Capability unit IIwc–2 (1.5b); woodland suitability group 2o3; recreation group 9.

Keweenaw Series

The Keweenaw series consists of well-drained, nearly level to moderately steep soils on till plains. These soils formed in dominantly sandy materials.

In a representative profile the surface layer is black loamy sand 1 inch thick. The subsurface layer is reddish-gray loamy sand 7 inches thick. The upper part of the subsoil is dark reddish-brown, friable loamy sand 5 inches thick; the next part is reddish-brown, friable loamy sand 16 inches thick; the next part is yellowish-red, loose sand 3 inches thick; and the lower part is reddish-brown, firm fine sandy loam and weak-red, firm loamy sand 7 inches thick. The underlying material is reddish-brown loamy sand.

Keweenaw soils have low available water capacity and low natural fertility. Permeability is moderately rapid.

Most areas of these soils are used as woodland. Some areas have been cleared but are idle.

Representative profile of Keweenaw loamy sand, 0 to 6 percent slopes, in a wooded area, in the SE¼SW¼ sec. 12, T. 46 N., R. 18 W., Alger County:

A1—0 to 1 inch, black (10YR 2/1) loamy sand; weak, fine, granular structure; very friable; very strongly acid; abrupt, smooth boundary.

A2—1 to 8 inches, reddish-gray (5YR 5/2) loamy sand; very weak, medium, granular structure; very friable; very strongly acid; abrupt, smooth boundary.

B21hir—8 to 13 inches, dark reddish-brown (5YR 3/2) loamy sand; weak, medium, subangular blocky structure; friable; very strongly acid; clear, irregular boundary.

B22ir —13 to 29 inches, reddish-brown (5YR 4/4) loamy sand; weak, medium, subangular blocky structure; friable; strongly acid; abrupt, wavy boundary.

B3—29 to 32 inches, yellowish-red (5YR 4/6) sand; single grained; loose; strongly acid; abrupt, smooth boundary.

B′&A′—32 to 39 inches, reddish-brown (2.5YR 4/4) fine sandy loam (B′), exterior of peds covered with weak-red (2.5YR 5/2) coarse loamy sand (A′); weak, coarses subangular blocky structure; firm; vesicular pore, in peds; clay bridging between sand grains and in some pores; strongly acid; clear, smooth boundary.

C—39 to 60 inches, reddish-brown (2.5YR 5/4 and 5YR 4/4) loamy sand; massive; friable; 3 percent coarse fragments; medium acid.

The solum ranges from 36 to 50 inches in thickness. Reaction throughout the profile ranges from very strongly acid to medium acid.

The A1 horizon has hue of 5YR to 10YR, value of 2, and chroma of 1 or 2. The A2 horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2.

The B21hir horizon is dark reddish-brown (5YR 3/2 or 3/3) loamy sand or loamy fine sand. The B22ir horizon has hue of 5YR, value of 3 to 5, and chroma of 2 to 6. It is loamy sand or loamy fine sand. The B3 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is sand or loamy sand.

The B′ part of the B′&A′ horizon has hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 3 or 4. It is commonly 1 or 2 texture classes finer than the material above or below. The A′ part of the B′&A′ horizon has hue of 2.5YR or 5YR, value of 5 or 6, and chroma of 2 to 4. The B′&A′ horizon exhibits weak fragipan characteristics. It is friable to firm when moist and slightly hard when dry, and it is brittle in places.

The C horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 to 6. It is sand or loamy sand and has some thin sandy loam bands in a few places.

Keweenaw soils are near Blue Lake, Kalkaska, and Munising soils. They are generally finer textured in the upper part of the B horizon and C horizon than Blue Lake soils. They are finer textured than Kalkaska soils and have a B′&A′ horizon, which Kalkaska soils lack. They are coarser textured than Munising soils, and they lack the fragipan that is characteristic of Munising soils.

Keweenaw loamy sand, 0 to 6 percent slopes (KnB).—This soil is on till plains. It has the profile described as representative of the series. The underlying material is loamy sand till, but sand or sandy loam pockets are present in some areas. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are areas of Kalkaska, Blue Lake, Munising, and Steuben soils. Also included are some stony areas.

This soil is used mainly as woodland.

The major limitations to the use of this soil for crops are low natural fertility and droughtiness. Capability unit IIIs–4 (4a-a); woodland suitability group 2s1; recreation group 2.

Keweenaw loamy sand, 6 to 18 percent slopes (KnD).—This soil is on till plains. The underlying material is loamy sand till, but sand and sandy loam pockets are in some areas. Runoff is slow, and the hazard of erosion is moderate to severe.

Included with this soil in mapping are small areas of Kalkaska, Blue Lake, Munising, and Steuben soils. Also included are some stony areas.

This soil is used as woodland.

The major limitations to the use of this soil for crops are steepness, droughtiness, and low natural fertility. Capability unit IVe 9 (4a–a); woodland suitability group 2s1; recreation group 3.

Kinross Series

The Kinross series consists of poorly drained, nearly level soils on outwash plains, lake plains, and till plains. These soils formed in sandy material.

In a representative profile the surface layer is black muck 6 inches thick. The subsurface layer is grayish-brown sand 4 inches thick. The upper part of the subsoil is dark reddish-brown, nonsticky, nonplastic sand 14 inches thick, and the lower part is dark-brown, nonsticky, nonplastic sand 18 inches thick. The underlying material, at a depth of 36 inches, is brown sand.

Kinross soils have very low available water capacity and low natural fertility. Permeability is very rapid. The seasonal high water table is near the surface much of the year. Runoff is slow or ponded.

Kinross soils are used as woodland.

Representative profile of Kinross mucky sand, in a wooded area, in the NW¼SE¼SE¼NW¼ sec. 15, T. 43 N., R. 19 W., Delta County:

O2—6 inches to 0, black (5YR 2/1) muck; weak, medium, granular structure; very friable; many roots; very strongly acid; clear, smooth boundary.

A2g—0 to 4 inches, grayish-brown (10YR 5/2) sand; few, fine faint, dark-gray (10YR 4/1) mottles; single grained; nonsticky; very strongly acid; clear, wavy boundary.

B21hir—4 to 6 inches, dark reddish-brown (5YR 3/2) sand; single grained; nonsticky; very strongly acid; gradual, wavy boundary.

B22ir—6 to 18 inches, dark reddish-brown (5YR 3/4) sand; few, medium, faint, dark reddish-brown (5YR 3/2) mottles; single grained; nonsticky; strongly acid; gradual, wavy boundary.

B3—18 to 36 inches, dark-brown (7.5YR 4/4) sand; single grained; nonsticky; strongly acid; gradual, wavy boundary.

C—36 to 60 inches, brown (7.5YR 5/4) sand; single grained; nonsticky; strongly acid.

The solum ranges from 20 to 44 inches in thickness. Reaction throughout the profile is very strongly acid or strongly acid.

About 4 to 6 inches of sphagnum moss is above the O2 horizon in a few areas. The O2 horizon has hue of 5YR to 10YR, value of 2, and chroma of 1 or 2. It is muck or mucky peat. The A2g horizon has hue of 2.5Y to 10YR, value of 5 or 6, and chroma of 1 or 2.

The B21hir horizon has hue of 5YR to 10YR, value of 2 to 4, and chroma of 2 or 3. The B22ir horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 2 to 6. The color of the B3 horizon is transitional between that of the B22ir horizon and the C horizon.

The C horizon has hue of 7.5YR to 10YR, value of 5 or 6, and chroma of 3 or 4. Mottling is absent or faint in the subsoil.

Kinross soils are near Au Gres, Roscommon, and Saugatuck soils. They have a B horizon that contains more organic matter and generally has a thicker, muckier surface layer than Au Gres soils. They have a darker B horizon than Roscommon soils. They lack the cemented B horizon that is characteristic of Saugatuck soils.

Kinross mucky sand (0 to 2 percent slopes) (Kr).—This soil is on outwash plains, lake plains, and till plains.

Included with this soil in mapping are a few small knolls of somewhat poorly drained Au Gres soils and some areas of very poorly drained Dawson soils. Also included are some areas of soils that have a lighter colored subsoil than that of this Kinross soil.

This soil is used as woodland.

The major limitations to the use of this soil as woodland and for crops are wetness, hazard of frost, high acidity, and low natural fertility. Capability unit VIIwc–3 (5c); woodland suitability group 5w1; recreation group 10.

Kiva Series

The Kiva series consists of well-drained, nearly level to steep soils on outwash plains and till plains. These soils formed in 12 to 24 inches of loamy material over gravelly and sandy material.

In a representative profile the surface layer is black sandy loam 2 inches thick. The subsurface layer is brown sandy loam 3 inches thick. The upper part of the subsoil is dark reddish-brown, friable sandy loam 7 inches thick, and the lower part is dark-brown, friable gravelly sandy loam 10 inches thick. The underlying material, at a depth of 22 inches, is brown sand and gravel.

Kiva soils have moderate available water capacity in the loamy layers and very low available water capacity in the underlying material. Natural fertility is low. Permeability

is moderate in the loamy layers and very rapid in the underlying material.

Kiva soils are used for hay and pasture, as woodland, and as a source of gravel.

Representative profile of Kiva sandy loam, 0 to 6 percent slopes, in a wooded area, in the SE¼SE¼SW¼ sec. 27, T. 42 N., R. 21 W., Delta County:

A1—0 to 2 inches, black (10YR 2/1) sandy loam; weak, fine, granular structure; very friable; 2 percent coarse fragments; slightly acid; abrupt, smooth boundary.

A2—2 to 5 inches, brown (10YR 5/3) sandy loam; weak, medium, granular structure; very friable; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

B21ir—5 to 12 inches, dark reddish-brown (5YR 3/4) sandy loam; weak, medium, subangular blocky structure; friable; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

B22ir—12 to 22 inches, dark-brown (7.5YR 4/4) gravelly sandy loam; weak, medium, subangular blocky structure; friable; 25 percent coarse fragments; slightly acid; gradual, wavy boundary.

IIC—22 to 60 inches, brown (7.5YR 5/4) stratified sand and gravel; single grained; loose; 25 percent coarse fragments; strongly effervescent; moderately alkaline.

The solum ranges from 12 to 24 inches in thickness. Reaction of the solum ranges from slightly acid to mildly alkaline. In cultivated areas there is a very dark brown (10YR 2/2) Ap horizon 6 to 8 inches thick. The A1 horizon is black (5YR 2/1 or 10YR 2/1). The A2 horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2 or 3.

The B21ir horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 3 or 4. The B22ir horizon has hue of 5YR to 10YR, value of 3 or 4, and chroma of 3 or 4. It is gravelly sandy loam or sandy loam.

The IIC horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 4. The gravel in the IIC horizon is dominantly limestone and a small amount of sandstone. The IIC horizon contains many cobblestones in a few places.

Kiva soils are near Chatham, Longrie, Onaway, and Summerville soils. They lack the bedrock that underlies Longrie and Summerville soils. They lack the clayey B'2 horizon and the loamy C horizon of Onaway soils. They have a thinner solum and a slightly coarser textured IIC horizon than Chatham soils.

Kiva sandy loam, 0 to 6 percent slopes (KsB).—This soil is on outwash plains and till plains. Sand, gravel, and cobblestones make up most of the underlying material, but some areas have limestone slabs in the substratum. This soil has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of Longrie and Summerville soils. Also included are some stony areas and a few areas where the subsoil is loamy sand or loam.

This soil is used as woodland and for farming. Adapted crops are grown, but the soil is mainly used for hay and pasture.

The major limitations to the use of this soil are droughtiness and low natural fertility.

This soil is a good source of gravel. Capability unit IIIs–4 (4a): woodland suitability group 2f1; recreation group 4.

Kiva sandy loam, 6 to 20 percent slopes (KsD).—This soil is on ridges and short side slopes on till plains and outwash plains. Runoff is slow to medium in the sloping areas and rapid in the steep areas. Most areas of this soil have grass and tree cover that greatly reduces runoff. The hazard of erosion is moderate to severe.

The surface layer and subsoil of this soil in a few areas contain cobblestones, and the substratum contains more large cobblestones and limestone slabs than Kiva sandy loam, 0 to 6 percent slopes. The surface layer is gravelly loamy sand in some areas.

Included with this soil in mapping are small areas where the underlying material is gravelly sandy loam or gravelly loamy sand. Also included in cultivated areas are soils, on small knobs and ridges, that have had part of the topsoil removed through erosion or by tillage.

Most of this soil is used as woodland.

The major limitations to the use of this soil are droughtiness, steepness, and the hazard of erosion.

This soil is a good source of gravel. Capability unit IVe–9 (4a); woodland suitability group 2f1; recreation group 6.

Lake Beaches

Lake beaches (0 to 4 percent slopes) (Lb) consists of a narrow strip of sandy beach and dunes along the shore of Lake Superior. The beach generally ranges from about 100 to 200 feet in width, but some dunes extend inland as much as 500 feet. This land type is adjacent to areas of Shelldrake soils in the vicinity of Au Train.

This land type is treeless, and the sand is blown readily by strong winds. Capability unit VIIIs–1; woodland suitability group not assigned; recreation group not assigned.

Limestone Rock Land

Limestone rock land (0 to 3 percent slopes) (Lm) consists of nearly level or gently sloping areas where limestone bedrock is within 10 inches of the surface (fig. 10). The soil material on the surface is dominantly black or dark-brown fine sandy loam or loam. Most areas are well drained, but some are seepy most of the year. In some areas the surface is covered by limestone slabs 1 foot to 2 feet in diameter, and other areas are nearly free of stones. A few areas have large limestone boulders on the surface.

Included with this land type in mapping are a few areas of Summerville soils where the soil material is more than 10 inches thick. In the larger areas are some limestone escarpments and some cobbly beach ridges about 3 or 4 feet high and 15 to 20 feet wide. Rock outcrops occupy from 1 to 10 percent of the total area.

Limestone rock land has very low available water capacity and is therefore very droughty. Runoff is slow or very slow. Water moves downward through fissures and fractures in the limestone.

Most areas of Limestone rock land are used as woodland. Tree species include varying amounts of white-cedar, balsam fir, aspen, and white birch. The hazard of windthrow is severe.

Some areas are used for grazing. Grazing is limited to spring months because of droughtiness during summer.

The major limitations to the use of this land type are shallow soil depth, droughtiness, and stoniness. Capability unit VIIIs 2; woodland suitability group not assigned; recreation group 12.

Figure 10.—A typical area of Limestone rock land. Stumps are white-cedar.

Longrie Series

The Longrie series consists of well drained or moderately well drained, nearly level to moderately steep soils on till plains and bedrock benches. These soils formed in loamy material 20 to 40 inches thick over limestone bedrock.

In a representative profile the surface layer is very dark grayish-brown sandy loam 8 inches thick. The subsurface layer is light brownish-gray sandy loam 2 inches thick. The upper part of the subsoil is dark reddish-brown, friable sandy loam 2 inches thick, the middle part is reddish-brown, friable sandy loam 6 inches thick, and the lower part is reddish-brown, friable loam 6 inches thick. The underlying material is light reddish-brown loam 4 inches thick. Limestone bedrock is at a depth of 28 inches.

Longrie soils have moderate available water capacity and medium natural fertility. Permeability is moderate.

Longrie soils are used for all adapted crops and as woodland. Hay, oats, and pasture are the main crops, but some potatoes, corn for silage, and dryfield beans are also grown.

Representative profile of Longrie sandy loam, 2 to 6 percent slopes, in a cultivated area, in the NW¼NW¼SW¼ sec. 36, T. 39 N., R. 22 W., Delta County:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) sandy loam; moderate, medium, granular structure; friable; less than 2 percent coarse fragments; neutral; abrupt, smooth boundary.

A2—8 to 10 inches, light brownish-gray (10YR 6/2) sandy loam; weak, thin, platy structure; friable; 2 percent coarse fragments; neutral; abrupt, broken boundary.

B21ir—10 to 12 inches, dark reddish-brown (5YR 3/4) sandy loam; weak, fine, granular structure; friable; 2 percent coarse fragments; neutral; clear, wavy boundary.

B22ir—12 to 18 inches, reddish-brown (5YR 4/4) sandy loam; weak, fine, granular structure; friable; 2 percent coarse fragments; neutral; abrupt, wavy boundary.

B3—18 to 24 inches, reddish-brown (5YR 4/3) loam; weak, fine, subangular blocky structure; friable; 2 percent coarse fragments; mildly alkaline; abrupt, wavy boundary.

C—24 to 28 inches, light reddish-brown (5YR 6/3) loam; weak, fine, subangular blocky structure; friable; 3 percent coarse fragments; strongly effervescent moderately alkaline; abrupt, smooth boundary.

IIR—28 inches, limestone bedrock.

The solum ranges from 18 to 36 inches in thickness. Depth to bedrock ranges from 20 to 40 inches but is dominantly 24 to 34 inches. Limestone flags are common in a few places. Reaction of the solum ranges from slightly acid to mildly alkaline; the higher reaction is in the lower part.

In undisturbed profiles there is a black (5YR 2/1 or 10YR 2/1) or dark reddish-brown (5YR 2/2) A1 horizon 1 to 4 inches thick. The Ap horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The A2 horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2.

The B21ir horizon has hue of 5YR to 10YR, value of 3 or 4, and chroma of 3 or 4. It is sandy loam or loam. The B22ir horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 to 6. It is sandy loam or loam. The B3 horizon has hue of

5YR to 7.5YR, value of 4 to 5, and chroma of 3 or 4. It is sandy loam or loam.

The C horizon has hue of 2.5YR to 10YR, value of 5 or 6, and chroma of 3 or 4. It is sandy loam or loam. The C horizon is mottled where the soil is moderately well drained.

Longrie soils are near Onaway, Summerville, Sundell, and Trenary soils. They have bedrock at a depth of 20 to 40 inches, which is lacking in Onaway and Trenary soils and is at a depth of 10 to 20 inches in Summerville soils. They lack the mottled B horizon that is characteristic of Sundell soils.

Longrie sandy loam, 0 to 2 percent slopes (LoA).—This soil is on till plains and bedrock benches. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of Onaway or Trenary soils where this soil is near its maximum depth. In these areas a clayey layer is in the lower part of the subsoil. Also included are areas of somewhat poorly drained Sundell soils in small depressions and small areas of Summerville soils.

This soil is used as woodland and for crops. Under proper management this soil is suited to adapted crops. Some of the shallower areas tend to be somewhat droughty.

The main limitation to the use of this soil is seasonal droughtiness in some of the shallower areas. Capability unit IIIs-2 (3/Ra); woodland suitability group 2o1; recreation group 4.

Longrie sandy loam, 2 to 6 percent slopes (LoB).—This soil is on till plains and bedrock benches. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are areas of Onaway or Trenary soils, where this soil approaches its maximum depth, and areas of Summerville soils. In these areas a clayey layer is in the lower part of the subsoil. Also included are areas of soils that have slopes of less than 2 percent and some areas of soils that have slopes of more than 6 percent.

This soil is used as woodland and for crops. It responds well to good management, and it can be used for all adapted crops. Some of the shallower areas tend to be droughty. Practices that control erosion and maintain organic-matter content are needed on this soil.

The major limitation to the use of this soil is seasonal droughtiness in some of the shallow areas. Capability unit IIIe-8 (3/Ra); woodland suitability group 2o1; recreation group 4.

Longrie and Summerville sandy loams, 6 to 18 percent slopes (LsD).—The soils in this mapping unit are in areas that are shallow over limestone bedrock. Longrie soils are 20 to 40 inches deep, and Summerville soils are 10 to 20 inches deep. Slopes that exceed 12 percent are seldom more than 100 feet long. Runoff is medium to rapid, and the hazard of erosion is severe. Soil depth is variable within short distances but ranges from about 10 to 40 inches.

Included with this soil in mapping are areas of limestone outcrop, in some of the steeper areas, and some very stony areas. Also included are a few areas where the slopes exceed 18 percent.

These soils are used for pasture or as woodland. Some of the shallower areas are droughty.

The major limitations to the use of these soils for crops are steepness and the hazard of erosion. Capability unit VIe-3 (3/Ra, Ra); woodland suitability group 2o1 for Longrie, 3d1 for Summerville; recreation group 12.

Lupton Series

The Lupton series consists of very poorly drained, nearly level or depressional soils on till plains and outwash plains. The soils formed in woody and herbaceous organic materials.

In a representative profile the surface layer is black mucky peat (hemic material) 3 inches thick. The next two layers are black muck (sapric material) that have a total thickness of 43 inches. The next layer is very dark brown mucky peat (hemic material) 13 inches thick. The lower layer, at a depth of 59 inches, is black mucky peat (hemic material).

Lupton soils have very high available water capacity and low natural fertility. Permeability is rapid. The seasonal high water table is at or near the surface most of the year, but it drops to a depth of 18 to 30 inches in extended dry periods. Runoff is very slow or ponded.

These soils are not used for crops, because of wetness and a severe hazard of frost. They are used as woodland and for wildlife habitat.

Storage of water is an important function of these soils. Most areas are directly connected to the surface drainage system and have streamflow through them.

Representative profile of Lupton muck, in an area of Carbondale, Lupton, and Rifle soils, in a wooded area, in the SW¼NW¼NW¼ sec. 24, T. 43 N., R. 20 W., Delta County:

Oe1—0 to 3 inches, black (5YR 2/1, broken face, rubbed and pressed) hemic material; about 50 percent fiber, 12 percent rubbed; weak, medium, subangular blocky structure; nonsticky; fibers are woody; neutral; abrupt, smooth boundary.

Oa1—3 to 7 inches, black (5YR 2/1, broken face, rubbed and pressed) sapric material; about 30 percent fiber, less than 10 percent rubbed; weak, medium, subangular blocky structure; nonsticky; fibers are woody; neutral; clear, wavy boundary.

Oa2—7 to 46 inches, black (5YR 2/1, broken face, rubbed and pressed) sapric material; about 30 percent fiber, less than 10 rubbed; weak, coarse, subangular blocky structure; nonsticky; fibers are woody; slightly acid; clear, wavy boundary.

Oe2—46 to 59 inches, very dark brown (10YR 2/2), black (10YR 2/1, rubbed and pressed) hemic material; about 50 percent fiber, 15 percent rubbed; massive; nonsticky; fibers are herbaceous; slightly acid; clear, wavy boundary.

Oe3—59 to 73 inches, black (10YR 2/1, broken face, rubbed and pressed) hemic material; about 65 percent fiber; 30 percent rubbed; massive; nonsticky; fibers are herbaceous; slightly acid.

The organic material is more than 51 inches thick. Most of the organic material is woody or herbaceous. Woody fragments are common in most areas, and they consist of stumps, branches, or twigs. The organic material has hue of 5YR to 10YR, value of 2 or 3, and chroma of 0 to 3. Reaction ranges from medium acid to mildly alkaline.

The surface tier is dominantly sapric material but commonly is a combination of hemic and sapric material. The subsurface tier is dominantly sapric material. More than two-thirds of the subsurface and bottom tiers is sapric material. Some layers of hemic material are present, but they make up less than one-third, by volume, of the subsurface and bottom tiers.

Lupton soils are near Carbondale, Cathro, Rifle, and Tacoosh soils. They have less hemic material in the subsurface tier than Carbondale and Rifle soils. They lack a mineral layer at a depth of 16 to 51 inches, which is characteristic of Cathro and Tacoosh soils.

Made Land

Made land (Ma) consists of areas where the original soil material has been covered or removed to such an extent that a recognizable soil profile is no longer evident. It also consists of areas that have been artificially filled with earth or trash, or both, and smoothed. Made land is most commonly in and around urban areas. Onsite investigation is needed to determine the potential of each area for use and management. Capability unit VIIIs–3; woodland suitability group not assigned; recreation group not assigned.

Mancelona Series

The Mancelona series consists of well-drained, nearly level to moderately steep soils on outwash plains. These soils formed in sandy material, 20 to 40 inches thick, and in the underlying gravelly and sandy material.

In a representative profile the surface layer is black organic matter 2 inches thick. The subsurface layer is brown loamy sand 6 inches thick. The upper part of the subsoil is dark-brown, very friable loamy sand 9 inches thick, the middle part is strong-brown, very friable loamy sand 5 inches thick, and the lower part is reddish-brown, friable light gravelly clay loam 4 inches thick. The underlying material, at a depth of 24 inches, is brown gravel, sand, and gravelly loamy sand.

Mancelona soils have low available water capacity and low natural fertility. Permeability is moderately rapid.

A very small acreage of these soils is used for crops. Most areas of these soils are used as woodland. The soils are a potential source of gravel.

Representative profile of Mancelona loamy sand, 6 to 18 percent slopes, in a wooded area, in the NW¼SE¼SE¼ sec. 31, T. 43 N., R. 20 W., Delta County:

O2—2 inches to 0, black (5YR 2/1) organic matter, weak, fine, granular structure; very friable; neutral; abrupt, smooth boundary.

A2—0 to 6 inches, brown (7.5YR 5/2) loamy sand; very weak, fine, granular structure; very friable; neutral; clear, wavy boundary.

B21ir—6 to 15 inches, dark-brown (7.5YR 4/4) loamy sand; weak, fine, subangular blocky structure; very friable; neutral; gradual, wavy boundary.

B22ir—15 to 20 inches, strong-brown (7.5YR 5/6) loamy sand; weak, fine, subangular blocky structure; very friable; neutral; gradual, wavy boundary.

IIB'2t—20 to 24 inches, reddish-brown (5YR 4/4) light gravelly clay loam; weak, fine, subangular blocky structure; friable; thin clay films on pebbles and gravel; 20 percent coarse fragments; neutral; clear, wavy boundary.

IIC—24 to 60 inches, brown (7.5YR 5/4) stratified gravel, sand, and gravelly loamy sand; single grained; loose; 25 percent coarse fragments; slightly effervescent; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness but is most commonly 20 to 30 inches thick, which corresponds to the depth to stratified material. Reaction throughout the solum ranges from medium acid to neutral.

The O2 horizon is black (5YR 2/1 or 7.5YR 2/0). A black (5YR 2/1) A1 horizon 1 inch to 2 inches thick is present in some places. In cultivated areas there is a dark-brown (7.5YR 3/2) or very dark gray (10YR 3/1) Ap horizon 7 to 10 inches thick. The A2 horizon is brown (7.5YR 5/2) or pinkish gray (7.5YR 6/2).

A thin, dark reddish-brown (5YR 3/4) Bhir horizon 1 inch to 2 inches thick is present in some places. The B21ir horizon has hue of 5YR or 7.5YR, value of 4, and chroma of 4 or 6. The B22ir horizon has hue of 7.5YR, value of 5 or 6, and chroma of 4 or 6.

A light yellowish-brown (10YR 6/4) loamy sand A'2 horizon 1 inch to 5 inches thick is present in some areas. The IIB'2t horizon has hue of 5YR or 7.5YR, and value and chroma of 4. It ranges from sandy loam to gravelly clay loam. The IIC horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 or 4. It ranges from stratified gravelly loamy sand to gravel and sand.

Mancelona soils are near East Lake, Kalkaska, Karlin, and Rubicon soils. They have a Bt horizon, which East Lake soils lack. They have a Bt horizon and gravel in the underlying material, both of which Kalkaska, Karlin, and Rubicon soils lack. They are coarser textured in the A horizon and in the upper part of the B horizon than Karlin soils.

Mancelona loamy sand, 0 to 6 percent slopes (McB).—This soil is on outwash plains. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of Kalkaska and East Lake soils. Also included are areas where the surface layer is sand or sandy loam.

Most of this soil is used as woodland. A small acreage is used for small grain or pasture.

The major limitations to the use of this soil for crops are droughtiness, low natural fertility, and the hazard of soil blowing.

This soil is a potential source of gravel. Capability unit IIIs–4 (4a); woodland suitability group 2s1; recreation group 2.

Mancelona loamy sand, 6 to 18 percent slopes (McD).—This soil is on outwash plains. It has the profile described as representative of the series. Runoff is slow to medium, and the hazard of erosion is moderate.

Included with this soil in mapping are a few areas of Kalkaska and East Lake soils and some areas where the surface layer is sand. Also included are some areas where the slope exceeds 18 percent.

Nearly all areas of this soil are used as woodland.

The major limitations to the use of this soil are droughtiness, steepness, low natural fertility, and the hazard of erosion.

This soil is a potential source of gravel. Capability unit IVe–9 (4a); woodland suitability group 2s1; recreation group 3.

Marsh

Marsh (0 to 2 percent slopes) (Mh) consists of inland lake borders that are under water much of the year and of areas bordering Lake Michigan. Along Lake Michigan these areas range from less than 100 feet to ¼ mile in width. These areas are wider during periods of low water. Most areas remain wet, even when the water recedes, as a result of seepage from adjacent higher areas

The soil material in areas of Marsh ranges from sand to clay loam. Bedrock is at a depth of less than 2 feet to more than 10 feet. The soil material varies, but it generally is the same as that in which soils adjacent to the shore formed.

Trees do not grow on Marsh. The vegetation is commonly sedges, cattail, reeds, and other water-loving plants. The areas of Marsh have little value except for wildlife habitat and for hunting. Some areas are excellent duck habitat. Capability unit VIIIwe–2; woodland suitability group not assigned; recreation group not assigned.

Melita Series

The Melita series consists of well drained and moderately well drained, nearly level or gently sloping soils on till plains and outwash plains. These soils formed in 40 to 60 inches of sandy material and in the underlying loamy material.

In a representative profile the surface layer is black sand 2 inches thick. The subsurface layer is pinkish-gray sand 8 inches thick. The upper part of the subsoil is dark reddish-brown, very friable sand 3 inches thick, the next part is dark-brown, very friable sand 6 inches thick, the next part of the subsoil is reddish-brown, very friable sand 25 inches thick, the next lower part is reddish-brown, firm heavy loam and reddish-gray, firm sandy loam 4 inches thick, and the lower part is reddish-brown, firm heavy loam 6 inches thick. The underlying material, at a depth of 54 inches, is reddish-brown loam.

Melita soils have very low available water capacity in the sandy layers and high available water capacity in the underlying material. Natural fertility is low. Permeability is rapid in the sandy layers and moderately slow in the loamy layers. Runoff is slow.

Most areas of these soils are used as woodland.

Representative profile of Melita sand, 0 to 6 percent slopes, in a wooded area, in the NE¼NE¼NE¼ sec. 3, T. 40 N., R. 18 W., Delta County:

A1—0 to 2 inches, black (5YR 2/1) sand; weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

A2—2 to 10 inches, pinkish-gray (7.5YR 6/2) sand; weak fine, granular structure; very friable; slightly acid; abrupt, wavy boundary.

B21hir—10 to 13 inches, dark reddish-brown (5YR 3/2) sand; weak, fine, granular structure; very friable; slightly acid; abrupt, irregular boundary.

B22ir—13 to 19 inches, dark-brown (7.5YR 4/4) sand; weak, fine, subangular blocky structure; very friable; medium acid; clear, irregular boundary.

B3—19 to 44 inches, strong-brown (7.5YR 5/6) sand; weak, fine, subangular blocky structure; very friable; medium acid; abrupt, wavy boundary.

IIB'&A'—44 to 48 inches, reddish-brown (2.5YR 4/4) heavy loam (B'); most peds surrounded by reddish-gray (5YR 5/2) sandy loam (A'); A' part makes up about 15 percent of the horizon; weak, medium, subangular blocky structure; firm; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

IIB'2t—48 to 54 inches, reddish-brown (2.5YR 4/4) heavy loam; weak, medium, subangular blocky structure; firm; thin clay films on faces of peds; occasional tongues of IIA'2 material; neutral; abrupt, wavy boundary.

IIC—54 to 60 inches, reddish-brown (2.5YR 5/4) loam; weak, medium, platy structure; friable; contains few limestone pebbles; 3 percent coarse fragments; slightly effervescent; mildly alkaline.

The solum ranges from 46 to 74 inches in thickness. Depth to loamy material ranges from 40 to 60 inches. Reaction of the solum ranges from strongly acid to neutral, and it is commonly more acid in the sandy horizons than in the loamy horizons.

The A1 horizon is black (5YR 2/1 or 10YR 2/1) or very dark gray (10YR 3/1). In cultivated areas the Ap horizon is very dark brown (10YR 2/2) or very dark gray (10YR 3/1) and is 6 to 10 inches thick. The A2 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 1 or 2.

The B21hir horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 2 to 4. It is sand, loamy sand, or loamy fine sand. The B22ir horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 to 8. It is sand, loamy sand, or loamy fine sand. The B3 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 4 or 6. It is sand, loamy sand, or loamy fine sand.

The A' part of the IIB'&A' horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand or sandy loam. The B' part of the IIB'&A' horizon and the IIB'2t horizon has hue of 2.5YR to 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loam to clay loam. The IIC horizon has hue of 2.5YR to 10YR, value of 4 or 5, and chroma of 4 or 6. The IIC horizon is stony in a few places.

Melita soils are near Kalkaska, Menominee, and Rubicon soils. They have loamy material at a depth of 40 to 60 inches, which Kalkaska and Rubicon soils lack and which is at a depth of 20 to 40 inches in Menominee soils.

Melita sand, 0 to 6 percent slopes (MIB).—This soil is on till plains and outwash plains. Runoff is slow or very slow. Soil blowing is a hazard if the soil is exposed.

Included with this soil in mapping are a few areas of Kalkaska or Menominee soils. Also included are some moderately eroded places in areas where this soil has been cultivated. The surface layer is dark reddish brown in these areas.

Most of this soil is used as woodland. The soil is used for crops only where it is included in a larger field of finer textured soils, and it generally is managed the same as these soils.

The major limitations to the use of this soil for crops are droughtiness, low natural fertility, and the hazard of soil blowing. Capability unit IVs–4 (5/2a); woodland suitability group 2s1; recreation group 1.

Menominee Series

The Menominee series consists of well drained and moderately well drained, nearly level to moderately steep soils on till plains, lake plains, and outwash plains. These soils formed in sandy materials, 20 to 40 inches thick, and in the underlying loamy materials.

In a representative profile the surface layer is black loamy sand 10 inches thick. The subsurface layer is reddish-gray sand 3 inches thick. The upper part of the subsoil is dark reddish-brown, very friable sand 2 inches thick, the next part is yellowish-red, very friable sand 15 inches thick, and the next part is brown, firm fine sandy loam and reddish-brown, firm heavy loam about 6 inches thick. The lower part of the subsoil is reddish-brown, firm heavy loam. The underlying material, at a depth of 42 inches, is light reddish-brown loam.

Menominee soils have low available water capacity in the sandy layers and high available water capacity in the underlying material. Natural fertility is low. Permeability is rapid in the sandy layers and moderately slow in the underlying material.

Menominee soils are used as woodland and for adapted crops.

Representative profile of Menominee loamy sand, 0 to 6 percent slopes, in a cultivated field, in the SW¼SW¼SE¼ sec. 28, T. 38 N., R. 24 W., Delta County:

Ap—0 to 10 inches, black (10YR 2/1) loamy sand; weak, fine, granular structure; very friable; strongly acid; abrupt, smooth boundary.

A2—10 to 13 inches, reddish-gray (5YR 5/2) sand; weak, fine, granular structure; friable; very strongly acid; abrupt, wavy boundary.

B21ir—13 to 15 inches, dark reddish-brown (5YR 3/4) sand; weak, fine, granular structure; very friable; strongly acid; clear, wavy boundary.

B22ir—15 to 30 inches, yellowish-red (5YR 4/6) sand; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

IIA'&B'—30 to 36 inches, brown (7.5YR 5/2) fine sandy loam (A') and reddish-brown (5YR 4/3) heavy loam (B'); the finer textured material occupies the center of peds; moderate, medium, subangular blocky structure; firm; 2 percent coarse fragments; medium acid, gradual, irregular boundary.

IIB'2t—36 to 42 inches, reddish-brown (5YR 4/3) heavy loam; moderate, coarse, subangular blocky structure; firm; thin clay films on faces of peds; 2 percent coarse fragments; neutral; abrupt, wavy boundary.

IIC—42 to 60 inches, light reddish-brown (5YR 6/4) loam; moderate, fine, angular blocky structure; friable; 3 percent coarse fragments; strongly effervescent; moderately alkaline.

The solum ranges from 24 to 50 inches in thickness. The sandy material ranges from 20 to 40 inches in thickness but is most commonly 20 to 36 inches thick. Reaction in the solum ranges from strongly acid to neutral, and the higher reaction is in the loamy part of the solum.

The Ap horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. In wooded areas there is a black (N 2/0) A1 horizon 1 to 3 inches thick. The A2 horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 1 to 3. It is sand or loamy sand.

The B21ir horizon has hue of 5YR, value of 2 to 4, and chroma of 2 to 4. It is sand or loamy sand. In some places there is a B3 horizon that has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4. The A' part of the IIA'&B' horizon has hue of 2.5YR to 7.5YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand to fine sandy loam. The B' part of the IIA'&B' horizon and IIB'2t horizon has hue of 2.5YR to 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loam to clay loam. The IIC horizon has hue of 2.5YR to 10YR, value of 4 to 6, and chroma of 3 or 4. It is loam or clay loam.

Menominee soils are near Gilchrist, Iosco, Kalkaska, and Melita soils. They have an A'&B' horizon, which Gilchrist soils lack. They lack the mottled B horizons that are characteristic of Iosco soils. They have loamy underlying material, which Kalkaska soils lack. They have loamy material at a depth of 20 to 40 inches instead of at a depth of 40 to 60 inches, which is typical of Melita soils.

Menominee loamy sand, 0 to 6 percent slopes (MnB).—This soil is on till plains, lake plains, and outwash plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of Kalkaska and Melita soils and a few areas of Gilchrist soils in Schoolcraft County. Also included are a few areas, in Schoolcraft County, where the sandy layers are about 16 inches thick.

Most of this soil is used as woodland. It is used for crops where it is in fields of finer textured soils. Management that builds up organic-matter content and natural fertility and reduces the risk of soil blowing is needed on this soil.

The major limitations to the use of this soil for crops are droughtiness, low natural fertility, and the hazard of soil blowing. Capability unit IIIs-4 (4/2a); woodland suitability group 2s1; recreation group 2.

Menominee loamy sand, 6 to 18 percent slopes (MnD).—This soil is on till plains. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of Kalkaska and Melita soils and areas of Gilchrist soils in Schoolcraft County. Also included are some areas that are moderately eroded. The surface layer is dark reddish brown in these areas.

Most of this soil is used as woodland. This soil is used for crops only where it is a part of a larger field of finer textured soils. Practices that increase organic-matter content and natural fertility and reduce the risk of erosion are needed on this soil.

The major limitations to the use of this soil for crops are droughtiness, low natural fertility, and the hazard of erosion. Capability unit IVe-9 (4/2a); woodland suitability group 2s1; recreation group 3.

Munising Series

The Munising series consists of well drained or moderately well drained, nearly level to very steep soils on till plains and moraines (fig. 11). These soils formed in loamy materials.

In a representative profile the surface layer is black sandy loam 1 inch thick. The subsurface layer is pinkish-gray sandy loam 5 inches thick. The upper part of the subsoil is dark reddish-brown, friable sandy loam 7 inches thick; the next part is reddish-brown, friable light sandy loam 3 inches thick; and the lower part is light reddish-brown, firm light loamy sand and reddish-brown, firm sandy loam 30 inches thick, and it is commonly a strongly developed fragipan. The underlying material, at a depth of 46 inches, is reddish-brown sandy loam.

Munising soils have moderate available water capacity above the fragipan. The roots of most plants do not penetrate the fragipan and underlying layers, so water is not available to them. Natural fertility is medium. Permeability is slow to moderately slow in the fragipan and moderate above and below the fragipan.

The fragipan in this soil results in shallow rooting of many plants. Most areas of these soils are used as woodland.

Representative profile of Munising sandy loam, 0 to 6 percent slopes, in a wooded area, in the NW¼NE¼ sec. 1, T. 46 N., R. 21 W., Alger County:

A1—0 to 1 inch, black (10YR 2/1) sandy loam; weak, medium, granular structure; very friable; less than 2 percent coarse fragments; very strongly acid; abrupt, smooth boundary.

A2—1 to 6 inches, pinkish-gray (7.5YR 6/2) sandy loam; weak, fine, subangular blocky structure; very friable; less than 2 percent coarse fragments; strongly acid; abrupt, wavy boundary.

B21hir—6 to 9 inches, dark reddish-brown (5YR 2/2) sandy loam; weak, fine, subangular blocky structure; friable; less than 2 percent coarse fragments; very strongly acid; clear, wavy boundary.

B22ir—9 to 13 inches, dark reddish-brown (5YR 3/4) sandy loam; weak, fine, subangular blocky structure; friable; less than 2 percent coarse fragments; very strongly acid; abrupt, wavy boundary.

B23—13 to 16 inches, reddish-brown (5YR 4/4) light sandy loam; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; strongly acid; abrupt, wavy boundary.

A'&B'x—16 to 46 inches, light reddish-brown (5YR 6/3) light loamy sand (A') and reddish-brown (2.5YR 4/4) sandy loam (B'); the A'2 material occurs around peds of B'2t material; weak, coarse, subangular blocky structure; firm when moist; very hard when dry; vesicular; thin clay films in pores and on faces of peds; 2 percent coarse fragments; medium acid; gradual, smooth boundary.

C—46 to 60 inches, reddish-brown (2.5YR 5/4) sandy loam; weak, medium, subangular blocky structure; friable; slightly compact; 2 percent coarse fragments; medium acid.

Figure 11.—**An area of a Munising sandy loam showing traffic problems caused by a perched water table in spring.**

The solum ranges from 34 to 60 inches in thickness. Depth to the fragipan ranges from 15 to 20 inches. Reaction throughout the profile ranges from very strongly acid to slightly acid. The entire profile is stony in some areas, and sandstone is dominant.

The A1 horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. In cultivated areas the A1 and A2 horizons are mixed to form a very dark gray (10YR 3/1) plow layer 6 to 8 inches thick. The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2.

The B21hir horizon has hue of 5YR and value and chroma of 2 or 3. It is sandy loam or fine sandy loam. The B22ir horizon has hue of 5YR, value of 3 or 4, and chroma of 3 to 6. It is sandy loam or fine sandy loam. The B23 horizon generally is reddish brown (5YR 4/4). It is sandy loam or loamy sand. This horizon is commonly part of the fragipan.

The A′ part of the A′&B′x horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 2 or 3. It is sandy loam or loamy sand. The B′ part of the A′&B′x horizon has hue of 10R to 5YR, value of 4 or 5, and chroma of 3 or 4. The A′2 and B′2t horizons generally are combined; the A′ part makes up about 40 to 50 percent of the A′&B′ horizon and is around peds of the B′ part. In some areas the A′ and B′ horizons occur separately. The fragipan has developed in the A′ horizon or A′&B′ horizon. Development of the fragipan ranges from weak to strong but is most commonly strong.

The C horizon has hue of 10R to 5YR, value of 3 to 5, and chroma of 4 or 6.

Munising soils are near Onota, Skanee, Steuben, and Yalmer soils. They lack bedrock at a moderate depth, which is characteristic of Onota soils. They lack mottles in the upper part of the B horizon, which is typical of Skanee soils. They have a finer textured C horizon than Steuben soils. They have a finer textured B1r horizon than Yalmer soils.

Munising sandy loam, 0 to 6 percent slopes (MuB).—This soil is on till plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight. This soil dries out more slowly in spring than the more sloping Munising soils. The fragipan causes a temporarily perched water table. There is some lateral seepage along the fragipan in some areas.

Included with this soil in mapping are a few small areas of Trenary soils in the northeastern part of Alger County and a few areas of Keweenaw, Skanee, Steuben, Onota, and Yalmer soils. Also included are some areas where sandstone bedrock is at a depth of about 4 to 6 feet. Near Ackerman Lake, on Michigan State Highway 94, sand is at a depth of 50 to 70 inches.

Most of this soil is used as woodland. Only a small acreage has been cleared, and some of this is idle.

The major limitations to the use of this soil for crops are moderate droughtiness and the presence of a strong fragipan. Capability unit IIe-3 (3a-a); woodland suitability group 2d1; recreation group 4.

Munising sandy loam, 6 to 18 percent slopes (MuD).—This soil is on moraines and till plains. Runoff is slow to medium, and the hazard of erosion is moderate. This

soil dries out faster in spring than less sloping Munising soils. There is some lateral seepage above the fragipan in spring in some areas.

Included with this soil in mapping are areas of Steuben, Blue Lake, Kalkaska, Onota, and Keweenaw soils. Also included are a few areas where sand or sandstone bedrock is below a depth of 50 to 80 inches.

Nearly all this soil is used as woodland. Only a small acreage has been cleared, and most of this is idle.

The major limitations to the use of this soil for crops are steepness and the hazard of erosion. Capability unit IVe–4 (3a–a); woodland suitability group 2d1; recreation group 6.

Munising sandy loam, 18 to 40 percent slopes (MuE).—This soil is on moraines. Runoff is medium, and the hazard of erosion is severe.

Included with this soil in mapping are areas of Steuben, Blue Lake, Karlin, and Kalkaska soils. Also included are a few areas of Munising soils that have slopes of less than 18 percent.

This soil is used as woodland. The major limitations to the use of this soil are steepness and the hazard of erosion. Capability unit VIIe–2 (3a–a); woodland suitability group 2d2; recreation group 7.

Nahma Series

The Nahma series consists of poorly drained, nearly level soils on till plains and bedrock benches. These soils formed in loamy material 20 to 40 inches thick over limestone bedrock.

In a representative profile the surface layer is black muck 4 inches thick over black loam 5 inches thick. The upper part of the subsoil is mottled, gray, friable loam 4 inches thick, the middle part is mottled, brown, friable fine sandy loam 6 inches thick, and the lower part is mottled, pale-brown, friable loam about 10 inches thick. The underlying material is mottled, light greenish-gray, friable loam and weathered limestone. Limestone bedrock is at a depth of 29 inches.

Nahma soils have moderate available water capacity and medium natural fertility. Permeability is moderate. The seasonal high water table is within 12 inches of the surface much of the time but drops to below the bedrock contact in extended dry periods. Runoff is very slow or ponded.

A few scattered areas of Nahma soils are used for pasture, but nearly all areas are used as woodland.

Representative profile of Nahma loam, in a wooded area, in the NW¼NW¼NW¼ sec. 26, T. 40 N., R. 21 W., Delta County:

O2—4 inches to 0, black (5YR 2/1) muck; weak, medium, granular structure; very friable; neutral; clear, smooth boundary.

A1—0 to 5 inches, black (10YR 2/1) loam; moderate, medium, granular structure; friable; neutral; clear, smooth boundary.

B21g—5 to 9 inches, gray (10YR 5/1) loam; common, medium, faint, dark-gray (10YR 4/1) mottles; and few, fine, distinct, olive-brown (2.5Y 4/4) mottles; weak, medium, subangular blocky structure; friable; 2 percent coarse fragments; neutral; clear, smooth boundary.

B22—9 to 15 inches, brown (7.5YR 5/4) fine sandy loam; few, medium, faint, brown (10YR 5/3) mottles; weak, medium, platy structure; friable; 2 percent coarse fragments; neutral; abrupt, smooth boundary.

B3—15 to 25 inches, pale-brown (10YR 6/3) loam; common, medium, distinct, yellowish-brown (10YR 5/6 and 5/8) and white (10YR 8/2) mottles; massive; friable; 3 percent coarse fragments; mildly alkaline; clear, wavy boundary.

Cg—25 to 29 inches, light greenish-gray (5G 7/1) loam and weathered limestone bedrock; common, fine, prominent, light olive-brown (2.5Y 5/6) mottles; massive; friable; 3 percent coarse fragments; slightly effervescent; moderately alkaline; abrupt, smooth boundary.

IIR—29 inches, limestone bedrock.

The solum ranges from 15 to 30 inches in thickness. Depth to bedrock ranges from 20 to 40 inches. Reaction of the solum ranges from slightly acid to mildly alkaline. Many limestone slabs and fragments are present throughout the profile in a few places.

The O2 horizon and the A horizon are black (10YR 2/1 or 5YR 2/1).

The B21g horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is loam or sandy loam. The B22 horizon has hue of 10YR to 5YR, value of 4 to 6, and chroma of 3 or 4. It is loam or sandy loam.

The B3 horizon has hue of 10YR to 5YR, value of 4 to 6, and chroma of 3 or 4. It is loam or sandy loam. The Cg horizon has hue of 2.5Y to 5G, value of 6 or 7, and chroma of 1 to 6.

Nahma soils are near Ensley, Angelica, and Ruse soils. They have bedrock at a depth of 20 to 40 inches, which Ensley and Angelica soils lack, and which is at a depth of 10 to 20 inches in Ruse soils.

Nahma loam (0. to 2 percent slopes) (Nh).—This soil is on till plains and bedrock benches.

Included with this soil in mapping are a few areas of somewhat poorly drained Sundell soils, at higher elevations, and areas of Ruse, Ensley, and Angelica, and Chippeny soils. Also included are areas that are very stony, a few areas in the northern part of Alger County that are underlain by mildly alkaline sandstone bedrock, and some areas of poorly drained sand overlying limestone at a depth of 20 to 40 inches.

Nearly all this soil is used as woodland. Most cleared areas are used for pasture.

Tile drainage of this soil is not practical, because of depth to bedrock and lack of adequate outlets.

The major limitations to the use of this soil are wetness, depth to bedrock, and the hazard of frost. Capability unit IIIwc–4 (3/Rbc); woodland suitability group 4w1; recreation group 10.

Nester Series

The Nester series consists of well drained or moderately well drained, nearly level or gently sloping soils on till plains. These soils formed in loamy material.

In a representative profile the surface layer is dark-brown silt loam 8 inches thick. The subsurface layer is pinkish-gray silt loam 1 inch thick. The upper part of the subsoil is reddish-brown, firm silty clay loam 5 inches thick. It contains tongues of pinkish-gray silt loam. The lower part of the subsoil is reddish-brown, firm, heavy silty clay loam 6 inches thick. The underlying material is reddish-brown silty clay loam that extends to a depth of 60 inches or more.

Nester soils have high available water capacity and high natural fertility. Permeability is moderately slow.

Nester soils are used for hay, oats, and pasture. They are well suited to all adapted crops, except such root crops as potatoes.

Representative profile of Nester silt loam, 0 to 2 percent slopes, in a cultivated area, in the NE¼SW¼SE¼ sec. 17, T. 39 N., R. 18 W., Delta County:

Ap—0 to 8 inches, dark-brown (10YR 3/3) silt loam; moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—8 to 9 inches, pinkish-gray (7.5YR 6/2) silt loam; weak, thin, platy structure; friable; slightly acid; clear, broken boundary.

B&A—9 to 14 inches, reddish-brown (5YR 5/3 and 5/4) silty clay loam and pinkish-gray (7.5YR 6/2) tongues of silt loam; strong, medium, subangular blocky structure; firm; clay flows on faces of peds; neutral; clear, wavy boundary.

B2t—14 to 20 inches, reddish-brown (5YR 4/3) heavy silty clay loam; moderate, medium, angular blocky structure; firm; clay flows on faces of peds; neutral; abrupt, wavy boundary.

C—20 to 60 inches, reddish-brown (2.5YR 4/4) silty clay loam; weak, medium, subangular blocky structure; firm; slightly effervescent; moderately alkaline.

The solum ranges from 18 to 22 inches in thickness. Reaction of the solum is slightly acid or neutral.

The Ap horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 3. The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3.

The character of the B&A horizon varies considerably. In places it is absent or an A2 horizon occurs as coatings on the faces of peds in the upper part of the B2t horizon. The A2 horizon generally tongues into the B2t horizon. The B2t horizon has hue of 2.5YR or 5YR, value of 4, and chroma of 3 or 4. It is clay loam or silty clay loam.

The C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam or silty clay loam. Loam or sandy loam lenses are in the C horizon in some areas. A few faint mottles are in the C horizon in moderately well drained areas.

Nester soils in the survey area have redder colors and a thinner solum than are defined as within the range for the series. These differences do not affect use or behavior of the soils.

Nester soils are near Fairport and Kawkawlin soils. They lack bedrock within a depth of 20 to 40 inches, which is characteristic of Fairport soils. They lack mottles in the B horizon, which are typical of Kawkawlin soils.

Nester silt loam, 0 to 2 percent slopes (NsA).—This soil is on till plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few depressional areas of somewhat poorly drained Kawkawlin soils and a few areas of Fairport soils. Also included are areas near Isabella and near Garden Creek in the vicinity of Garden where the soils are stratified and contain lenses of silt loam. There are also many areas where limestone bedrock is at a depth of about 4 to 6 feet.

This soil does not dry out so soon in spring as do the more sloping Nester soils. Random tiling is needed in some areas. Careful investigations should be made before tiling, because in places the presence of bedrock limits the depth at which tile can be placed. Organic-matter content should be maintained in order to preserve soil structure.

Most of this soil is used for hay or pasture. Capability unit IIs–1 (1.5a); woodland suitability group 2o3; recreation group 5.

Nester silt loam, 2 to 6 percent slopes (NsB).—This soil is on till plains. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas near Isabella that are stratified and contain lenses of silt loam. Also included are a few areas of Fairport soils and many areas where limestone bedrock is at a depth of about 4 to 8 feet.

Practices that maintain soil structure are needed on this soil. Practices that control erosion are needed on the steeper slopes. Capability unit IIe–1 (1.5a); woodland suitability group 2o3; recreation group 5.

Onaway Series

The Onaway series consists of well drained and moderately well drained, nearly level to moderately steep soils on till plains and moraines. These soils formed in loamy materials.

In a representative profile the surface layer is black fine sandy loam 3 inches thick. The subsurface layer is brown fine sandy loam 1 inch thick. The upper part of the subsoil is dark-brown, friable fine sandy loam 6 inches thick, the middle part is reddish-brown, friable sandy loam 4 inches thick, and the lower part is dark reddish-brown, firm clay loam 8 inches thick. The underlying material is reddish-brown loam.

Onaway soils have high available water capacity and high natural fertility. Permeability is moderately slow.

Onaway soils are well suited to adapted crops. These soils are the most extensively farmed soils in the survey area. They are also used as woodland, and northern hardwoods are the main timber species.

Representative profile of Onaway fine sandy loam, 2 to 6 percent slopes, in a wooded area, on the west side of the NW¼NW¼NW¼ sec. 7, T. 39 N., R. 23 W., Delta County:

A1—0 to 3 inches, black (10YR 2/1) fine sandy loam; weak, fine, granular structure; friable; less than 2 percent coarse fragments; slightly acid; abrupt, smooth boundary.

A2—3 to 4 inches, brown (7.5YR 5/2) fine sandy loam; weak, thin, platy structure; friable; less than 2 percent coarse fragments; slightly acid; abrupt, wavy boundary.

B2ir—4 to 10 inches, dark-brown (7.5YR 4/4) fine sandy loam; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; slightly acid; clear, wavy boundary.

A'2—10 to 14 inches, reddish-brown (5YR 5/3) sandy loam; weak, coarse, subangular blocky structure; friable; vesicular; less than 2 percent coarse fragments; neutral; abrupt, wavy boundary.

B'2t—14 to 22 inches, dark reddish-brown (5YR 3/4) clay loam; weak, coarse, subangular blocky structure; firm; thin clay films on faces of peds; 2 percent coarse fragments; mildly alkaline; abrupt, wavy boundary.

C—22 to 60 inches, reddish-brown (5YR 5/4) loam; weak, fine, subangular blocky structure; friable; 3 percent coarse fragments; strongly effervescent; moderately alkaline.

The solum ranges from 16 to 30 inches in thickness but is dominantly 18 to 24 inches thick. Reaction of the solum ranges from slightly acid to mildly alkaline.

In cultivated areas the Ap horizon is 6 to 8 inches thick. It has hue of 7.5YR or 10YR, value of 2 to 4, and chroma of 2 or 3. The A2 horizon generally is entirely mixed with the plow layer in these areas. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1). The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2.

The B2ir horizon has hue of 5YR to 7.5YR, value of 3 to 5, and chroma of 4 to 6. It is fine sandy loam or loam.

The A'2 horizon has hue of 5YR to 7.5YR, value of 5 to 7, and chroma of 2 or 3. It is sandy loam or fine sandy loam.

The B'2t horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. It ranges from heavy loam to clay loam.

The C horizon has hue of 5YR to 10YR, value of 5 to 7, and

chroma of 3 or 4. It is loam or light loam. The C horizon contains limestone slabs and cobblestones in many places.

Onaway soils are near Charlevoix, Longrie, and Trenary soils. They lack the mottled B horizon that is characteristic of Charlevoix soils. They lack bedrock at a depth of 20 to 40 inches, which is typical of Longrie soils. They have a thinner solum than Trenary soils.

Onaway fine sandy loam, 0 to 2 percent slopes (On A).—This soil is on till plains and moraines. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas where the surface layer is loam and areas of somewhat poorly drained Charlevoix soils in depressions or shallow waterways. In some areas in southern Delta County, the reaction of the surface layer is higher than in this Onaway soil. Also included are a few areas of Longrie soils and many areas where limestone bedrock is at a depth of about 4 to 8 feet.

This soil is used for crops and as woodland. The soil is well suited to all crops commonly grown in the survey area. It can be farmed intensively if the fertility level is maintained.

Random tiling is needed in some moderately well drained areas. Capability unit IIe–2 (2.5a); woodland suitability group 2o1; recreation group 4.

Onaway fine sandy loam, 2 to 6 percent slopes (On B).—This soil is on till plains and moraines. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight to moderate.

Included with this soil in mapping are a few areas of somewhat poorly drained Charlevoix soils in wet spots and in drainageways and some areas of Longrie soils. Also included are many areas where limestone bedrock is at a depth of about 4 to 8 feet. A few areas of Onaway soils in the southern part of Delta County are more alkaline in the upper part than this Onaway soil. A small acreage of soils has a gravelly loam substratum. A few small knobs, ¼ to 1 acre in size, that have steeper slopes are included. Where these steeper areas are cultivated, the subsoil is exposed as the result of erosion and the movement of soil by machinery. These areas are less productive than the other areas of this mapping unit. A few areas that have slopes of less than 2 percent are also included.

This soil is used for crops and as woodland. This is the most extensively farmed soil in the survey area. It is well suited to all crops grown in the survey area (fig. 12). It can be farmed intensively under good management.

The major limitations to the use of this soil for crops are the hazard of erosion and the small size and irregular shape of the areas. Capability unit IIe–2 (2.5a); woodland suitability group 2o1; recreation group 4.

Onaway fine sandy loam, 6 to 12 percent slopes (OnC).—This soil is in small, commonly complex areas on till plains and moraines. Runoff is slow to medium, depending on the amount and kind of plant cover, and the hazard of erosion is moderate.

Figure 12.—Cultivated area of Onaway fine sandy loam.

Included with this soil in mapping are a few small areas of Emmet soils, a few areas where slopes exceed 12 percent, and a few stony areas. Also included in cultivated areas where slopes are complex are areas of soils, on the top of small knobs, that are so eroded that the subsoil is exposed. A few areas of soils have a profile that is more alkaline than that of this Onaway soil. The surface layer is loam in some areas.

This soil is used as woodland and for crops and hay. It is suited to all crops adapted to the area. To reduce erosion, more grass and legumes need to be included in the rotation than on less sloping Onaway soils. Contour farming, strip-cropping, and proper cropping systems are also needed to reduce erosion.

The major limitations to the use of this soil for crops are steepness and the hazard of erosion. Capability unit IIIe–5 (2.5a); woodland suitability group 2o1; *recreation* group 6.

Onaway fine sandy loam, 12 to 18 percent slopes (OnD).—This soil is on till plains and moraines. Many slopes are short and complex. Runoff is slow to rapid, depending on the amount and kind of plant cover, and the hazard of erosion is severe.

Included with this soil in mapping are a few areas where the surface layer is loam, some stony areas, areas where slopes exceed 18 percent, areas where the soils are more alkaline than this Onaway soil, and a few areas of Emmet soils. Also included, in cultivated areas where slopes are complex, are some knobs where erosion has exposed the subsoil.

Most of this soil is used as woodland or for pasture. Intensive management that includes contouring, strip-cropping, and long rotations is needed on this soil if it is to be used for crops.

The major limitations to the use of this soil for crops are steepness and the hazard of erosion. Capability unit IVe–4 (2.5a); woodland suitability group 2o1; recreation group 6.

Onota Series

The Onota series consists of well drained or moderately well drained, nearly level to very steep soils on shallow till plains and bedrock benches. These soils formed in loamy material 20 to 40 inches thick over sandstone bedrock.

In a representative profile the surface layer is very dark gray sandy loam 3 inches thick. The subsurface layer is grayish-brown sandy loam 4 inches thick. The upper part of the subsoil is dark reddish-brown, friable sandy loam 3 inches thick, the next part is reddish-brown, friable sandy loam 14 inches thick, the next part is reddish-brown, friable sandy loam 14 inches thick, and the lower part is reddish-brown, friable loamy sand 4 inches thick. The underlying material is brown and dark yellowish-brown sandstone bedrock.

Onota soils have moderate available water capacity and medium natural fertility. Permeability is moderate. A temporarily perched water table is above the bedrock for short periods in spring in a few areas.

Onota soils are used as woodland.

Representative profile of Onota sandy loam in an area of Onota-Deerton complex, 0 to 6 percent slopes, in a wooded area, in the SW¼SW¼NW¼ sec. 10, T. 47 N., R. 18 W., Alger County:

A1—0 to 3 inches, very dark gray (10YR 3/1) sandy loam; weak, medium, granular structure; friable; less than 2 percent coarse fragments; strongly acid; abrupt, wavy boundary.

A2—3 to 7 inches, grayish-brown (10YR 5/2) sandy loam; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; strongly acid; abrupt, wavy boundary.

B21hir—7 to 10 inches, dark reddish-brown (5YR 3/2) sandy loam; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; strongly acid; clear, wavy boundary.

B22ir—10 to 24 inches, reddish-brown (5YR 4/3) sandy loam; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; strongly acid; clear, wavy boundary.

IIB23—24 to 28 inches, reddish-brown (5YR 4/4) loamy sand; weak, medium, subangular blocky structure; friable; 2 percent coarse fragments; strongly acid; abrupt, wavy boundary.

IIIR1 –28 to 31 inches, brown (10YR 5/3) and dark yellowish-brown (10YR 4/4), soft, fractured sandstone; friable; neutral; clear, smooth boundary.

IIIR2—31 inches, brown (10YR 5/3) and dark yellowish-brown (10YR 3/4) sandstone bedrock.

The thickness of the solum and depth to bedrock range from 20 to 40 inches but are most commonly about 20 to 30 inches. Reaction throughout the solum ranges from slightly acid to strongly acid but is dominantly strongly acid.

The A1 horizon is very dark gray (10YR 3/1) or black (5YR 2/1). The A2 horizon has hue of 2.5YR to 10YR, value of 5 to 7, and chroma of 2 or 3.

The B21hir horizon has hue of 5YR or 7.5YR, value of 3, and chroma of 2 to 4. The B22ir horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 3 or 4. The IIB23 horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or loamy sand.

The sandstone is soft and fractured in the upper few inches in many areas. Reaction of the sandstone ranges from neutral to very strongly acid.

Onota soils are near Deerton and Munising soils. They are finer textured throughout the profile than Deerton soils. They lack the fragipan of Munising soils. They have bedrock at a depth of 20 to 40 inches, which Munising soils lack.

Onota-Chippeny complex, steep (15 to 70 percent slopes) (OoE).—This mapping unit consists of well drained and moderately well drained Onota sandy loam and very poorly drained Chippeny muck. Both of these soils are underlain by sandstone bedrock at a depth of less than 40 inches. Areas of this mapping unit are 100 to 650 feet wide and about ½ mile to 1½ miles long. Runoff is slow because of plant cover. The hazard of erosion is moderate.

Onota soils make up about 40 percent of this mapping unit and Chippeny soils make up about 30 percent. The remaining 30 percent is somewhat poorly drained Kawbawgam soils, poorly drained Burt soils, and sandstone outcrop. The wet soils are on short benches and in pockets in the less sloping areas of this mapping unit. Water seeps into these areas from adjacent areas during most of the year.

The soils in this mapping unit are used as woodland. Capability unit VIIe–3 (3/Ra, M/Rc); woodland suitability group 2r1 for Onota, 5w2 for Chippeny; recreation group 7.

Onota-Deerton complex, 0 to 6 percent slopes (OrB).—The soils in this mapping unit are shallow and occur on till plains and bedrock benches. Onota soils make up about 60 percent of this mapping unit, and Deerton soils make

up about 40 percent. An Onota soil in this complex has the profile described as representative of the series. The Onota soils are sandy loam, and the Deerton soils are sand or loamy sand. Deerton soils are mostly loamy sand. Both soils are underlain by sandstone bedrock at a depth of 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight.

The soils in this mapping unit are used as woodland.

The major limitations to the use of these soils are droughtiness and low fertility of the Deerton soils. Capability unit IIIe–8 (3/Ra, 4/Ra); woodland suitability group 2o1 for Onota, 3s1 for Deerton; recreation group 4.

Onota-Deerton complex, 6 to 18 percent slopes (OrD).—The soils in this mapping unit are on sandstone benches. Onota soils make up about 60 percent of the mapping unit, and Deerton soils make up about 40 percent. Onota soils are sandy loam, and Deerton soils are sandy or loamy sand. The Deerton soils are mostly loamy sand. Both soils are underlain by sandstone bedrock at a depth of 20 to 40 inches. Runoff is slow because of plant cover. The hazard or erosion is moderate.

Included with these soils in mapping are a few areas of Kalkaska or Munising soils. Also included are a few areas of seepy soils at the base of slopes.

The soils in this mapping unit are used as woodland.

The major limitations to the use of these soils are droughtiness, steepness, and the low fertility of the Deerton soils. Capability unit VIe 3 (3/Ra, 4/Ra); woodland suitability group 2o1 for Onota, 3s1 for Deerton; recreation group 6.

Otisco Series

The Otisco series consists of somewhat poorly drained, nearly level or gently sloping soils on till plains. These soils formed in dominantly sandy materials.

In a representative profile the surface layer is black loamy sand 7 inches thick. The subsurface layer is grayish-brown sand 2 inches thick. The upper part of the subsoil is mottled, dark-brown, very friable sand 8 inches thick, the next part is mottled, brown, very friable sand 7 inches thick, the next lower part is mottled, brown, friable sand and reddish-brown friable loamy sand 5 inches thick, the next part is mottled, reddish-brown, firm, very fine sandy loam 6 inches thick, and the lower part is reddish-brown, friable loamy sand 6 inches thick. The underlying material at a depth of 41 inches is light reddish-brown sand.

Otisco soils have low available water capacity and low natural fertility. Permeability is moderately rapid. The seasonal high water table fluctuates between depth of 1 foot and 2 feet. Runoff is slow.

Some areas of the Otisco soils are used for oats, hay, or pasture. Most of the areas are used as woodland.

Representative profile of Otisco loamy sand, 0 to 6 percent slopes, in a cultivated area, in the SW¼SE¼-SE¼SW¼ sec. 29, T. 38 N., R. 24 W., Delta County:

Ap —0 to 7 inches, black (10YR 2/1) loamy sand; weak, coarse, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—7 to 9 inches, grayish-brown (10YR 5/2) sand; very weak, coarse, granular structure; very friable; medium acid; abrupt, wavy boundary.

B2ir —9 to 17 inches, dark-brown (7.5YR 4/4) sand; common, coarse, faint, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

A'2—17 to 24 inches, brown (10YR 5/3) sand; common, coarse, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; very friable; medium acid; diffuse, wavy boundary.

A'&B'—24 to 29 inches, brown (10YR 5/3) sand (A') and reddish-brown (5YR 4/3) loamy sand (B'); few, coarse, faint, dark-brown (7.5YR 4/4) mottles; weak, coarse, subangular blocky structure; friable; slightly acid; gradual, wavy boundary.

IIB'21—29 to 35 inches, reddish-brown (5YR 4/3) very fine sandy loam; few, coarse, faint, strong-brown (7.5YR 5/6) mottles; massive; firm; neutral; gradual, wavy boundary.

IIIB'22—35 to 41 inches, reddish-brown (5YR 4/3) loamy sand; massive; friable; mildly alkaline; gradual, smooth boundary.

IIIC—41 to 60 inches, light reddish-brown (5YR 6/3) sand; single grained; loose; mildly alkaline.

The solum ranges from 24 to 50 inches in thickness. Reaction of the solum ranges from strongly acid to slightly acid in the upper part and from slightly acid to mildly alkaline in the lower part.

The Ap horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. A black (10YR 2/1) A1 horizon 1 to 4 inches thick is in undisturbed areas. The A2 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 1 to 3. It is sand or loamy sand.

The B2ir horizon has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 3 or 4. It is sand or loamy sand. A B22ir horizon is present in some places. The A'2 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 or 4. It is sand or loamy sand.

The A' part of the A' & B' horizon has hue of 7.5 YR or 10YR, value of 5 or 6, and chroma of 3 or 4. The B' part of the A' & B' horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4.

The IIB'22 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It ranges from loamy sand to very fine sandy loam. The IIIB'23 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It ranges from loamy sand to fine sandy loam. The IIIC horizon has hue of 5YR or 7.5YR, value of 4 or 6, and chroma of 3 or 4. It is neutral to mildly alkaline in reaction.

Otisco soils are in landscape positions similar to those of Au Gres and Iosco soils. They have A' and B' horizons, which Au Gres soils lack. They lack the loamy C horizon that is characteristic of Iosco soils.

Otisco loamy sand, 0 to 6 percent slopes (OtB).—This soil is in small areas on till plains. Slopes are dominantly about 1 to 4 percent.

Included with this soil in mapping are a few areas of Au Gres soils and a few areas where the surface layer is sand. Also included on small knolls are areas of well-drained Blue Lake soils and some areas of poorly drained soils that have a sandy loam surface layer.

Most of this soil is used as woodland. Some areas are used for oats, hay, or pasture.

The major limitations to the use of this soil for crops are seasonal wetness and low natural fertility. Capability unit IIIwc–5 (4b); woodland suitability group 3s3; recreation group 8.

Pickford Series

The Pickford series consists of poorly drained, nearly level soils on lake plains. These soils formed in clayey lacustrine material.

In a representative profile the surface layer is black muck 3 inches thick over mottled, very dark gray silt

loam 4 inches thick. The upper part of the subsoil is mottled, brown, very friable loamy fine sand 5 inches thick, and the lower part is mottled, reddish-brown, very firm silty clay 9 inches thick. The underlying material is reddish-brown silty clay.

Pickford soils have high available water capacity and high natural fertility. Permeability is very slow. The seasonal high water table is within 12 inches of the surface much of the year, but it drops below a depth of 3 feet during summer. Runoff is slow or very slow.

This soil is used mainly as woodland. A few acres are used for pasture.

Representative profile of Pickford silt loam, in a wooded area, in the SW¼SE¼NE¼ sec. 25, T. 39 N., R. 19 W., Delta County:

O2—3 inches to 0, black (10YR 2/1) muck; weak, fine, granular structure; very friable; neutral; abrupt, smooth boundary.

A1—0 to 4 inches, very dark gray (5YR 3/1) silt loam; common, fine, prominent, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

B21—4 to 9 inches, brown (10YR 5/3) loamy fine sand; few, medium, faint, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; very friable; mildly alkaline; abrupt, smooth boundary.

B22 -9 to 18 inches, reddish-brown (5YR 5/4) silty clay; common, fine, faint, yellowish-red (5YR 5/6) mottles; weak, medium, angular blocky structure; very firm; mildly alkaline; clear, wavy boundary.

C—18 to 60 inches, reddish-brown (5YR 5/3) silty clay; massive; very firm; slightly effervescent; moderately alkaline.

The solum ranges from 16 to 24 inches in thickness. Reaction of the solum ranges from neutral to mildly alkaline.

The A1 horizon is very dark gray (5YR 3/1) or black (5YR 2/1). The B21 horizon has hue of 10YR, value of 5, and chroma of 2 or 3. The B22 horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4.

The C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. Thin lenses of fine sand or silt are in the C horizon in some areas. This soil is saturated with water during winter and spring.

Pickford soils in the survey area are not within the range defined for the series, because they lack gray colors in the upper part of the profile. This difference does not affect the usefulness or behavior of the soils.

Pickford soils are near Pickford soils, moderately wet, and are in landscape positions similar to those of Bruce soils, coarse variant. They are saturated with water during a greater period and have more organic matter in the surface layer than Pickford soils, moderately wet. They have a finer textured subsoil and substratum than Bruce soils, coarse variant.

Pickford silt loam (0 to 2 percent slopes)(Pc).—This soil is on lake plains.

Included with this soil in mapping are a few slightly higher areas of Pickford soils, moderately wet variant. Also included are a few areas where the mucky surface layer or sandy subsurface layer is thicker than that of this Pickford soil.

This soil is used mainly as woodland. A small acreage has been cleared and is used for pasture.

This soil can be adequately drained for cultivated crops by use of ditches. Lack of adequate outlets limits drainage by tile.

The major limitations to the use of this soil for crops are wetness, poor tilth, and the hazard of frost. Capability unit IIIwc–1 (1c); woodland suitability group 4w1; recreation group 10.

Pickford Series, Moderately Wet

The Pickford series, moderately wet, consists of somewhat poorly drained, nearly level or gently sloping soils on lake plains. These soils formed in clayey lacustrine material.

In a representative profile the surface layer is very dark gray silt loam 6 inches thick. The subsurface layer is brown silt loam 2 inches thick. The subsoil is mottled, reddish-brown, firm silty clay 6 inches thick. The underlying material is mottled, reddish-brown silty clay.

Pickford soils, moderately wet, have high available water capacity and high natural fertility. Permeability is very slow. The seasonal high water table fluctuates between depths of about 1 foot to 2 feet. Water ponds for short periods following heavy rains and in spring. Runoff is slow.

These soils are used mainly as woodland. Cleared areas are used for hay, small grain, and pasture.

Representative profile of Pickford silt loam, moderately wet, 0 to 4 percent slopes, in a cultivated area, in the southwest corner of the SE¼NE¼ sec. 25, T. 39 N., R. 19 W., Delta County:

Ap—0 to 6 inches, very dark gray (10YR 3/1) silt loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—6 to 8 inches, brown (7.5YR 5/2) silt loam; weak, medium, subangular blocky structure; friable; slightly acid; abrupt, wavy boundary.

B2—8 to 14 inches, reddish-brown (5YR 4/3) silty clay; common, fine, faint, yellowish-red (5YR 4/6) and grayish-brown (10YR 5/2) mottles; moderate, medium, angular blocky structure; firm; thin coatings of brown (7.5YR 5/2) A2 material on peds in upper part of horizon; neutral; clear, wavy boundary.

C—14 to 60 inches, reddish-brown (5YR 5/3) silty clay; common, fine, faint, yellowish-red (5YR 5/6) mottles in upper 12 inches; moderate, medium, angular blocky structure; firm; slightly effervescent; moderately alkaline.

The solum ranges from 14 to 25 inches in thickness. Reaction throughout the solum is slightly acid to neutral.

In undisturbed areas there is a black (10YR 2/1) A1 horizon 3 to 6 inches thick. The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 1 to 3.

The B2 horizon has hue of 2.5YR or 5YR and value and chroma of 3 or 4. The C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. Thin bands of silt are in the C horizon in some places.

Pickford soils, moderately wet, are near Brimley and Pickford soils. They lack the brown color in the upper part of the B horizon that is characteristic of Brimley soils, and they have finer textured B and C horizons than Brimley soils. They have less organic matter in the A horizon and are not saturated for so long a period as Pickford soils.

Pickford silt loam, moderately wet, 0 to 4 percent slopes (PfA).—This soil is on lake plains. It has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils that have a surface layer of loamy sand. Also included are areas of Pickford soils in low spots and some areas where the underlying material contains lenses and strata of silt.

Most of this soil is used as woodland. Cleared areas are used for hay, pasture, and small grain, or they are idle.

Ditches can be used to provide the drainage needed if hay, pasture, and small grain are grown. Tile outlets are

not readily available in all areas of this soil. Maintenance of organic-matter content helps to maintain good tilth.

The major limitations to the use of this soil are seasonal wetness, a slight hazard of frost, and poor tilth. Capability unit IIIwc–2 (1b); woodland suitability group 4w1; recreation group 9.

Pickford complex, 0 to 4 percent slopes (PkA).—This soil consists of one area about 1,100 acres in size. Pickford silt loam, moderately wet, makes up about 60 percent of the mapping unit, and poorly drained Pickford soils in depressions make up about 40 percent.

Included with these soils in mapping are a few areas of soils that have a surface layer of sandy loam. Also included are a few areas on low ridges where the sand is as much as 18 inches thick over silty clay; the soils in these areas are moderately well drained.

Most of this soil is used as woodland. Only a small acreage is cleared, and it is idle.

Ditching provides adequate drainage for cultivated crops. Tile outlets are not available in all areas of this soil.

The major limitations to the use of this soil for crops are seasonal wetness, poor tilth, and the hazard of frost. Capability unit IIIwc–2 (1b, 1c); woodland suitability group 4w1; recreation group 9.

Rifle Series

The Rifle series consists of very poorly drained, nearly level or depressional soils on till plains, lake plains, and outwash plains. These soils formed in woody or herbaceous organic material.

In a representative profile the surface layer is yellowish-brown peat (fibric material) 2 inches thick. The next layer is black peat (fibric material) 2 inches thick. The next layer is black muck (sapric material) 4 inches thick. The lower layer is dark reddish-brown mucky peat (hemic material) that extends to a depth of 60 inches.

Rifle soils have very high available water capacity and low natural fertility. Permeability is rapid. Downward movement of water is restricted by the seasonal high water table, which is at or near the surface most of the year. Runoff is very slow or ponded.

Rifle soils are used as woodland.

Rifle soils are mapped only with Carbondale and Lupton soils in this survey area.

Representative profile of Rifle peat in an area of Carbondale, Lupton, and Rifle soils, in a wooded area, in the NE¼SE¼NE¼ sec. 13, T. 39 N., R. 24 W., Delta County:

Oi1—0 to 2 inches, yellowish-brown (10YR 5/4, broken face and rubbed) and light yellowish-brown (10YR 6/4, pressed) fibric material; 100 percent fiber, nearly 100 percent rubbed; massive; nonsticky; fibers are sphagnum moss; neutral; clear, smooth boundary.

Oi2—2 to 4 inches, black (5YR 2/1, broken face and rubbed) and black (10YR 2/1, pressed) fibric material; about 90 percent fiber, 60 percent rubbed; massive; nonsticky; fibers are dominantly sphagnum moss and some woody fibers; mildly alkaline; abrupt, smooth boundary.

Oa—4 to 8 inches, black (5YR 2/1, broken face and rubbed) and dark reddish-brown (5YR 2/2, pressed) sapric material; about 30 percent fiber, less than 10 percent rubbed; weak, fine, granular structure; slightly sticky; fibers are woody; mildly alkaline; abrupt, smooth boundary.

Oe1—8 to 20 inches, dark reddish-brown (5YR 2/2, on broken face, rubbed, and pressed) hemic material; about 65 percent fiber, 17 percent rubbed; weak, very thick platy structure; nonsticky; fibers are woody; neutral; clear, smooth boundary.

Oe2—20 to 39 inches, dark reddish-brown (5YR 2/2, broken face and rubbed) and dark reddish-brown (5YR 3/3, pressed) hemic material; about 80 percent fiber, 17 percent rubbed; weak, very thick, platy structure; nonsticky; fibers are woody; neutral; gradual, smooth boundary.

Oe3—39 to 60 inches, dark reddish-brown (5YR 2/2, broken face, rubbed and pressed) hemic material; about 67 percent fiber, 15 percent rubbed; weak, very thick, platy structure; nonsticky; fibers are woody; neutral.

The organic material is more than 51 inches thick. Woody fragments, in the form of branches, roots, and stumps, are common in some areas. Reaction ranges from medium acid to mildly alkaline.

The surface tier is hemic material or fibric material, or both. It is herbaceous material in some areas and sphagnum moss in other areas. More than two-thirds of the subsurface tier and bottom tier is hemic materials of woody or herbaceous composition. Strata of sapric or fibric material are in some areas, but they make up less than one-third of the subsurface and bottom tiers. The subsurface tier and bottom tier have hue of 5YR to 10YR, value of 2 to 4, and chroma of 2 to 4. The surface tier is similar in color to the other tiers where it is hemic material. Where it is fibric material, value is normally 4 or 5. Hue and chroma are similar to those of the rest of the profile.

Rifle soils are near Carbondale, Greenwood, and Lupton soils. They contain more hemic material than Carbondale or Lupton soils. They are less acid than Greenwood soils.

Roscommon Series

The Roscommon series consists of poorly drained, nearly level soils on lake plains, outwash plains, and till plains. These soils formed in sandy material.

In a representative profile the surface layer is black muck 4 inches thick. The upper part of the underlying material is dark-gray sand 2 inches thick, the next part is mottled, grayish-brown sand 4 inches thick, the next part is mottled, dark grayish-brown sand 18 inches thick, and the lower part, at a depth of 24 inches, is grayish-brown sand.

Roscommon soils have very low available water capacity and low natural fertility. Permeability is rapid. The seasonal high water table is within 12 inches of the surface most of the year, but it drops to a depth of 2 or 3 feet late in summer in some areas. Runoff is very slow or ponded.

Most areas of these soils are used as woodland

Representative profile of Roscommon mucky sand, in a marshy area, in the SE¼NE¼NE¼ sec. 2, T. 39 N., R. 22 W., Delta County:

O2—4 inches to 0, black (5YR 2/1) muck; weak, medium, granular structure; very friable; slightly acid; abrupt, smooth boundary.

C1—0 to 2 inches, dark-gray (5Y 4/1) sand; single grained; loose; neutral; clear, wavy boundary.

C2—2 to 6 inches, grayish-brown (2.5Y 5/2) sand; few, coarse, prominent, strong-brown (7.5YR 5/6) mottles; single grained; loose; slightly acid; clear, wavy boundary.

C3—6 to 24 inches, dark grayish-brown (10YR 4 2) sand; common, coarse, distinct, strong-brown (7.5YR 5/6) and dark yellowish-brown (10YR 4/4) mottles; single grained; loose; neutral; clear, wavy boundary.

C4—24 to 60 inches, grayish-brown (10YR 5/2) sand; single grained; loose; neutral.

Reaction of the profile to a depth of 20 or 30 inches ranges from strongly acid to neutral. Below this depth it ranges from medium acid to mildly alkaline.

The O2 horizon is black (5YR 2/1 or 10YR 2/1). A black (10YR 2/1) A1 horizon 1 or 2 inches thick is present in some places. The C1 horizon has hue of 7.5YR to 5Y, value of 4 to 6, and chroma of 1 or 2. The texture resulting from mixing the O2 and C1 horizons is mucky sand.

The remaining horizons have hue of 7.5YR to 5Y, value of 4 to 6, and chroma of 1 or 2. Mottling is very faint or is absent in the C horizon.

Roscommon soils in most areas are near Au Gres, Kinross, and Saugatuck soils. They lack the dark reddish-brown and very dusky red Bhir horizon that is typical of Au Gres, Kinross, and Saugatuck soils. They lack the cemented B2ir horizon that is characteristic of Saugatuck soils.

Roscommon mucky sand (0 to 2 percent slopes) (Rc).—This soil is in depressional areas on lake plains, outwash plains, and till plains. It has the profile described as representative of the series.

Included with this soil in mapping are a few small knolls of somewhat poorly drained Au Gres soils and a few areas of Tawas soils. Also included are a few areas where the surface layer is loamy sand or mucky loamy sand. Bedrock, loam, or sandy loam are below a depth of about 4 feet in some areas, mainly near Lake Michigan. Some included areas are sandy soils that have a dark-brown subsoil.

This soil is mainly used as woodland. A small acreage has been cleared. Some areas are used for pasture, but most are idle.

The major limitations to the use of this soil are wetness, the hazard of frost, low natural fertility, and droughtiness in drained areas. Capability unit VIIwc–3 (5c); woodland suitability group 5w1; recreation group 10.

Roscommon-Kalkaska sands, 0 to 6 percent slopes (RkB).—The soils in this mapping unit are in such a complex pattern that they cannot be separated at the scale mapped. Roscommon soils commonly make up about 50 percent of this mapping unit, and Kalkaska soils make up about 35 percent. The remaining 15 percent is mainly somewhat poorly drained Au Gres soils and very poorly drained Tawas soils. Roscommon soils are nearly level and poorly drained. Kalkaska soils are gently sloping, are well drained and moderately well drained, and are on small ridges or knolls within areas of Roscommon soils.

These soils are used as woodland. Trees that commonly grow in the wet areas are white-cedar, alder, balsam fir, black spruce, aspen, balm-of-Gilead, black ash, red maple, and white birch. Among the trees that grow on Kalkaska soils are sugar maple, hemlock, white pine, red pine, balsam fir, aspen, and yellow birch.

The major limitations to the use of these soils are wetness, the hazard of frost, and low fertility. The Roscommon soils are droughty if they are drained. Capability unit VIIwc–3 (5c, 5a); woodland suitability group 5w1 for Roscommon, 3s1 for Kalkaska; recreation group 10.

Rousseau Series

The Rousseau series consists of well drained or moderately well drained, nearly level to very steep soils on lake plains and dunes. These soils formed in sandy materials.

In a representative profile the surface layer is black fine sand 1 inch thick. The subsurface layer is pinkish-gray fine sand 7 inches thick. The upper part of the subsoil is dark reddish-brown, very friable fine sand 3 inches thick, the middle part is yellowish-red, very friable fine sand 6 inches thick, and the lower part is strong-brown, very friable fine sand 8 inches thick. The underlying material is reddish-yellow fine sand.

Rousseau soils have low available water capacity and low natural fertility. Permeability is rapid. The hazard of soil blowing is severe.

Only a small acreage of Rousseau soils has been cleared, and it is used for hay or pasture. Most areas of these soils are used as woodland.

Representative profile of Rousseau fine sand, 0 to 6 percent slopes, in a wooded area, in the SW¼ NE¼ NW¼ SE¼ sec. 14, T. 41 N., R. 22 W., Delta County:

A1—0 to 1 inch, black (N 2/0) fine sand; very weak, medium, granular structure; very friable; strongly acid; abrupt, smooth boundary.

A2—1 to 8 inches, pinkish-gray (5YR 6/2) fine sand; very weak, medium, subangular blocky structure; very friable; very strongly acid; abrupt, wavy boundary.

B21ir—8 to 11 inches, dark reddish-brown (5YR 3/4) fine sand; very weak, fine, subangular blocky structure; very friable; very strongly acid; abrupt, irregular boundary.

B22ir—11 to 17 inches, yellowish-red (5YR 4/8) fine sand; very weak, fine and medium, subangular blocky structure; very friable; strongly acid; abrupt, irregular boundary.

B3—17 to 25 inches, strong-brown (7.5YR 5/6) fine sand; very weak, fine and medium, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

C—25 to 60 inches, reddish-yellow (7.5YR 6/6) fine sand; very weak, medium, subangular blocky structure; very friable; medium acid.

The solum ranges from about 20 to 32 inches in thickness. The entire profile is dominantly fine sand but includes a high percentage of very fine sand. Reaction of the solum is strongly acid to medium acid.

In cultivated areas the Ap horizon is a dark brown (7.5YR 3/2) and is 6 to 8 inches thick. In some places an O1 horizon 1 to 2 inches thick is directly over the A2 horizon, and there is no A1 horizon present. The A1 horizon is black (N 2/0 or 5YR 2/1). The A2 horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 1 or 2.

The B21ir horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. The B22ir horizon has hue of 5YR to 7.5YR, value of 4 to 6, and chroma of 6 to 8. The B3 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 6 to 8.

The C horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 3 to 6. It is medium acid or slightly acid. In some places that are moderately well drained, fine distinct mottles are at a depth below 24 inches.

Rousseau soils in most places are near Bohemian, Kalkaska, and Rubicon soils. They generally are coarser textured than Bohemian soils and are not loamy in the lower part of the B horizon, which is characteristic of Bohemian soils. They contain more fine sand throughout the profile than Kalkaska or Rubicon soils.

Rousseau fine sand, 0 to 6 percent slopes (RoB).—This soil is on lake plains. It has the profile described as representative of the series. Runoff is slow.

Included with this soil in mapping are a few areas of somewhat poorly drained Wainola soils in depressions and drainageways. Also included are some areas of Kalkaska and Karlin soils.

Most of this soil is used as woodland. A small acreage has been cleared, and it is used for hay and pasture.

The major limitations to the use of this soil for crops are droughtiness, low natural fertility, and the hazard of soil blowing. Capability unit IIIs–4 (4a); woodland suitability group 2s1; recreation group 1.

Rousseau fine sand, 6 to 18 percent slopes (RoD).—This soil is on lake plains and dunes. Runoff is slow to medium, depending on the amount of plant cover. The hazards of soil blowing and water erosion are severe.

Included with this soil in mapping are cultivated areas where erosion has exposed the subsoil on some of the steeper slopes. Also included are a few areas that have strata of very fine sand. There are also small areas of Kalkaska, Karlin, and Blue Lake soils.

Most of this soil is used as woodland. Only a small acreage has been cleared, and it is used for hay or pasture.

The major limitations to the use of this soil for crops are low natural fertility, the hazard of erosion, and droughtiness. Capability unit IVe–9 (4a); woodland suitability group 2s1; recreation group 3.

Rousseau fine sand, hilly (2 to 40 percent slopes) (RsD).—This soil is on old dunes that lie on an east-west axis. The dunes are as high as 40 to 50 feet. They range from about 250 to 600 feet in width and from about ¼ mile to about 1½ miles in length. North-facing slopes range from about 2 percent to about 20 percent. South-facing slopes are dominantly 35 to 40 percent and drop off abruptly. Runoff is slow to medium, depending on the amount of plant cover. The hazard of soil blowing is severe. This soil is more commonly associated with organic soils than with other Rousseau soils.

Included with this soil in mapping are a few areas of Rubicon soils and areas of somewhat poorly drained Wainola and Au Gres soils on the north edges of the dunes. In some included areas the upper part of the subsoil is not so dark as it is in this Rousseau soil. Also included are a few areas where there is discontinuous cementation in the subsoil. Some of the south-facing areas have slopes of less than 20 percent.

This soil is used as woodland.

The major limitations to the use of this soil are droughtiness, the hazard of erosion, steepness, and low natural fertility. Capability unit VIIs–1 (4a); woodland suitability group 2s2; recreation group 3.

Rubicon Series

The Rubicon series consists of well-drained, nearly level to very steep soils on outwash plains, lake plains, moraines, and dunes (fig. 13). These soils formed in sandy material.

In a representative profile the surface layer is black sand 1 inch thick. The subsurface layer is brown sand 3 inches thick. The upper part of the subsoil is reddish-brown, very friable sand 4 inches thick, the middle part is brown, very friable sand 6 inches thick that contains a few chunks of weakly cemented sand, and the lower part is brown, loose sand 13 inches thick. The underlying material is light-brown sand.

Rubicon soils have very low available water capacity and low natural fertility. Permeability is very rapid.

A few areas of these soils have been cleared, but they are idle or have been planted to pines. Nearly all areas of these soils are used as woodland.

Representative profile of Rubicon sand, 0 to 6 percent slopes, in a wooded area, in the NE¼NE¼NE¼ sec. 1, T. 45 N., R. 19 W., Alger County:

A1—0 to 1 inch, black (10YR 2/1) sand; weak, fine, granular structure; very friable, very strongly acid; abrupt, smooth boundary.

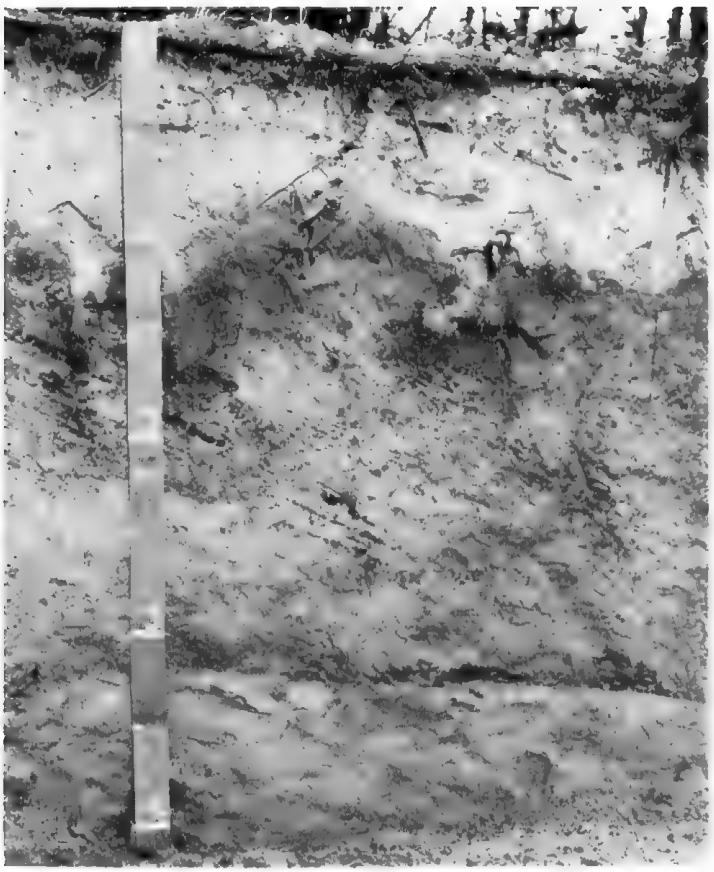

Figure 13.—**Profile of a Rubicon sand, showing stratification of the sand. In places this soil has a thick subsurface layer, but the subsoil is not strongly developed.**

A2—1 to 4 inches, brown (7.5YR 5/2) sand; weak, coarse, granular structure; very friable; very strongly acid; abrupt, wavy boundary.

B21ir—4 to 8 inches, reddish-brown (5YR 4/4) sand; weak, coarse, subangular blocky structure; very friable; very strongly acid; gradual, smooth boundary.

B22ir—8 to 14 inches, brown (7.5YR 4/4) sand; weak, coarse, granular structure; very friable; few chunks of weakly cemented ortstein; medium acid; gradual, smooth boundary.

B3—14 to 27 inches, brown (7.5YR 5/4) sand; single grained, loose; medium acid; abrupt, smooth boundary.

C—27 to 60 inches, light-brown (7.5YR 6/4) sand; single grained; loose; slightly acid.

The solum ranges from 20 to 36 inches in thickness. Reaction throughout the solum ranges from very strongly acid to medium acid. In areas that have been cultivated, the A1 and A2 horizons have been mixed to form a dark-gray (10YR 4/1) Ap horizon. The A1 horizon is black (5YR 2/1 or 10YR 2/1). The A2 horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 1 or 2.

The B21ir horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. Value and chroma of 3 occur only where the B21ir horizon is less than 2 inches thick. A thin, discontinuous Bhir horizon less than 1 inch thick is present in a few places. It has value and chroma of 3 or less. The B22ir horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4 to 8. Weakly cemented chunks of ortstein are present in the B21 and B22 horizons in many places. The B3 horizon is transitional in color between the B22ir horizon and the C horizon.

The C horizon has hue of 5YR or 7.5YR, value of 5 to 7, and chroma of 3 to 8. It is medium acid to slightly acid.

Rubicon soils have textures similar to those of Croswell and Kalkaska soils. They lack the mottles in the upper part of the C horizon, which are characteristic of Croswell soils. They lack the continuous dark reddish-brown Bh horizon that is typical of Kalkaska soils.

Rubicon sand, 0 to 6 percent slopes (RuB).—This soil is on outwash plains and lake plains. It has the profile described as representative of the series. Runoff is very slow, and the hazard of soil blowing is severe.

Included with this soil in mapping are a few small areas of well drained Kalkaska soils and moderately well drained Croswell soils. Also included, where this soil is near organic soils, are areas of somewhat poorly drained Au Gres soils and poorly drained Roscommon soils. Scattered bands of coarse sand and fine gravel are below a depth of 48 inches in some areas.

This soil is used mainly as woodland. A large acreage is in red pine and jack pine plantations.

Severe limitations to the use of this soil are droughtiness, low natural fertility, and the hazard of soil blowing. Capability unit VIIs–1 (5.3a); woodland suitability group 2s3; recreation group 1.

Rubicon sand, 6 to 18 percent slopes (RuD).—This soil is on moraines and outwash plains. Runoff is slow and the hazard of water erosion is slight because of rapid infiltration and rapid permeability. The hazard of soil blowing is severe.

Included with this soil in mapping are a few areas of more strongly developed Kalkaska soils and areas of moderately well drained Croswell soils in depressions. Also included are areas of Rubicon soils that have slopes of less than 6 percent or more than 18 percent, and a few areas of soils near Lake Michigan that are higher in reaction than Rubicon soils.

This soil is used as woodland.

The major limitations to the use of this soil are low natural fertility, droughtiness, and the hazard of soil blowing. Capability unit VIIs–1 (5.3a); woodland suitability group 2s3; recreation group 3.

Rubicon sand, 18 to 40 percent slopes (RuE).—This soil is on moraines and outwash plains. Runoff is slow, and the hazards of erosion and soil blowing are severe.

Included with this soil in mapping are a few areas of less sloping Rubicon and Kalkaska soils and a few small areas of soils near Lake Michigan that are higher in reaction than Rubicon soils. Also included, in Alger County, are a few areas of steep fine sands that support stands of northern hardwoods.

This soil is used as woodland.

The major limitations to the use of this soil are steepness, low natural fertility, droughtiness, and the hazard of erosion. Capability unit VIIs–1 (5.3a); woodland suitability group 2s4; recreation group 7.

Ruse Series

The Ruse series consists of poorly drained, nearly level soils on shallow till plains and on bedrock benches. These soils formed in loamy material 10 to 20 inches thick over limestone bedrock.

In a representative profile the surface layer is black silt loam 4 inches thick. The upper part of the subsoil is mottled, olive-gray, friable silt loam 3 inches thick and the lower part is mottled, pale-olive, friable sandy loam 4 inches thick. The underlying material is limestone bedrock.

Ruse soils have moderate available water capacity and medium natural fertility. Permeability is moderate, but downward movement of water is restricted by bedrock. The seasonal high water table is near the surface much of the year, but it drops below the bedrock contact during summer in some areas. Runoff is very slow or ponded.

Most areas of these soils are used as woodland. Some areas are used for pasture. Many of the cleared areas are idle.

Representative profile of Ruse silt loam, in a wooded area, in the NW¼NE¼NE¼ sec. 20, T. 39 N., R. 21 W., Delta County:

A1—0 to 4 inches, black (5Y 2/1) silt loam; weak, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

B21g—4 to 7 inches, olive-gray (5Y 5/2) silt loam; few, medium, faint, dark grayish-brown (2.5Y 4/2) mottles; weak, medium, subangular blocky structure; friable; 3 percent coarse fragments; slightly effervescent; mildly alkaline; abrupt, smooth boundary.

B22—7 to 11 inches, pale-olive (5Y 6/3) sandy loam; many, medium, distinct, light olive-brown (2.5Y 5/6) mottles; weak, fine, subangular blocky structure; friable; 3 percent coarse fragments; slightly effervescent; moderately alkaline; abrupt, smooth boundary.

IIR—11 inches, limestone bedrock.

The thickness of the solum and the depth to bedrock range from 10 to 20 inches but are most commonly 10 to 14 inches. Reaction throughout the profile ranges from neutral to moderately alkaline.

The A1 horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1. The B21g horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 2. It is silt loam, loam, or sandy loam. The B22 horizon has hue of 10YR to 5Y, value of 5 or 6, and chroma of 3 or 4. It is sandy loam or loam. A 1- to 3-inch layer, which appears to be residuum from the bedrock, is immediately above the limestone bedrock in some places.

Some Ruse soils have a moderately alkaline reaction in the solum and so are outside of the range defined for the series. This difference, however, does not affect the usefulness or behavior of these soils.

Ruse soils in most places are near Ensign and Nahma soils. They have a grayer B horizon than Ensign soils. They have bedrock at a depth of 10 to 20 inches instead of at a depth of 20 to 40 inches, which is characteristic of Nahma soils.

Ruse silt loam (0 to 2 percent slopes) (Rv).—This soil is on shallow till plains and limestone bedrock benches.

Included with this soil in mapping are a few areas of somewhat poorly drained Ensign soils and poorly drained Nahma soils. Also included are a few areas where the soils are less than 10 inches deep and some areas where as much as 12 inches of muck is on the surface.

Most of this soil is used as woodland. Small cleared areas are used for pasture. Many of the cleared areas are idle or have reverted to brush.

The major limitations to the use of this soil are wetness and shallow soil depth. Capability unit VIIwc-2 (Rbc); woodland suitability group 4w1; recreation group 10.

Saugatuck Series

The Saugatuck series consists of somewhat poorly drained or poorly drained, nearly level or gently sloping soils on outwash plains and lake plains. These soils formed in sandy material.

In a representative profile the surface layer is black, partly decomposed leaves, grass, and roots and is 2 inches

thick. The subsurface layer is light-gray sand 10 inches thick. The upper part of the subsoil is mottled, very dusky red, loose sand 5 inches thick. The middle part of the subsoil is dark reddish-brown sand 6 inches thick. It is massive, very firm, and strongly cemented. The lower part of the subsoil is mottled, strong-brown sand 11 inches thick. It is massive, weakly cemented, and firm. The underlying material is yellowish-brown sand that extends to a depth of 60 inches or more.

Saugatuck soils have very low available water capacity and low natural fertility. Permeability is rapid in the loose or friable layers and slow in the cemented layers. The seasonal high water table fluctuates from a depth of less than 2 feet to a depth of 4 or 5 feet throughout the year. Runoff is slow.

These soils are used as woodland.

Representative profile of Saugatuck sand, 0 to 3 percent slopes, in a wooded area, in the SE¼SE¼NE¼ sec. 4, T. 41 N., R. 19 W., Delta County:

O2—2 inches to 0, black (5YR 2/1) partly decomposed leaves, grass, and roots; very friable; very strongly acid; abrupt, smooth boundary.

A2—0 to 10 inches, light-gray (10YR 7/1) sand; single grained; loose; strongly acid; abrupt, wavy boundary.

B21hir—10 to 15 inches, very dusky red (2.5YR 2/2) sand; few, coarse, faint, dark reddish-brown (5YR 3/3) mottles; single grained; loose; very strongly acid; clear, wavy boundary.

B22irm—15 to 21 inches, dark reddish-brown (2.5YR 3/4) sand; common, fine, distinct, dark reddish-brown (5YR 3/3) mottles; massive; very firm; strongly cemented ortstein; strongly acid; abrupt, irregular boundary.

B3m—21 to 32 inches, strong-brown (7.5YR 5/6) sand; many, medium, faint, reddish-yellow (7.5YR 6/8) mottles; massive; weakly cemented ortstein; firm; strongly acid; clear, wavy boundary.

C—32 to 60 inches, yellowish-brown (10YR 5/4) sand; single grained; loose; medium acid.

The solum ranges from 24 to 36 inches in thickness. Reaction throughout the solum is very strongly acid or strongly acid.

A black (5YR 2/1) A1 horizon 1 to 3 inches thick is present in some places. The A2 horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 1 or 2. The lower boundary ranges from clear, wavy to abrupt, irregular.

The B21hir horizon has hue of 2.5YR or 5YR, value of 2 or 3, and chroma of 2 or 3. This horizon is weakly to strongly cemented in some places. The lower boundary is irregular in some areas. The B22irm horizon has hue of 2.5YR or 5YR, value of 2 to 4, and chroma of 2 to 6. This horizon is commonly strongly cemented.

The B3m horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 4 to 6. In some places all boundaries are irregular and tongues of horizons extend downward into the next one or two horizons. Color, thickness, and degree of cementation of all parts of the B horizon are variable within short distances.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 or 4. It is strongly acid or medium acid.

The annual temperature of Saugatuck soils in the survey area is a few degrees cooler than is defined as within the range for the series, but this difference seems not to alter the usefulness or behavior of these soils.

Saugatuck soils in most places are near Au Gres, Kinross, and Roscommon soils. They have a cemented B horizon that is lacking in the Au Gres, Kinross and Roscommon soils. They have colors in the B horizon that are darker than those at similar depths in Roscommon soils.

Saugatuck sand, 0 to 3 percent slopes (ScA).—This soil is on lake plains and outwash plains. Included in mapping are a few areas of somewhat poorly drained Au Gres soils and poorly drained Kinross and Roscommon soils.

This soil is used as woodland.

The major limitations to the use of this soil are low natural fertility, wetness, restricted root zone, and the hazard of frost. Capability unit VIIwc–3 (5b–h); woodland suitability group 5w1; recreation group 8.

Shelldrake Series

The Shelldrake series consists of well drained or moderately well drained, nearly level to sloping soils on low beach ridges near Lake Superior. These soils formed in sandy material.

In a representative profile the surface layer is a mixture of black and light brownish-gray sand 1 inch thick. The subsurface layer is light brownish-gray sand 6 inches thick. The subsoil is light yellowish-brown, loose sand that is 11 inches thick and contains some brown spots. The underlying material to a depth of 42 inches is pale-brown sand that grades to mottled, white sand below a depth of 42 inches.

Shelldrake soils have very low available water capacity and low natural fertility. Permeability is very rapid. Runoff is very slow.

Shelldrake soils are used as woodland and for recreation. They are suitable for cabin sites and provide a view of Lake Superior.

Representative profile of Shelldrake sand, 0 to 8 percent slopes, in a wooded area, in the SE¼NE¼SE¼SW¼ sec. 19, T. 47 N., R. 18 W., Alger County:

O2&A2—0 to 1 inch, black (N 2/0) and light brownish-gray (10YR 6/2) sand; single grained; loose; very strongly acid; abrupt, smooth boundary.

A2—1 to 7 inches, light brownish-gray (10YR 6/2) sand; single grained; loose; strongly acid; abrupt, wavy boundary.

B2—7 to 18 inches, light yellowish-brown (10YR 6/4) sand; some spots of brown (10YR 5/3); single grained; loose; strongly acid; clear, irregular boundary.

C1—18 to 42 inches, pale-brown (10YR 6/3) sand; single grained; loose; strongly acid; clear, wavy boundary.

C2—42 to 60 inches, white (10YR 8/2) sand; many, coarse, distinct, brownish-yellow (10YR 6/6) and yellow (10YR 7/6) mottles; single grained; loose; medium acid.

The solum ranges from 16 to 28 inches in thickness. Reaction throughout the profile ranges from very strongly acid to medium acid.

In some places there is a black (N 2/0 or 5YR 2/1) A1 horizon less than 1 inch thick. The A2 horizon is light gray (10YR 6/1 to 7/1) or light brownish gray (10YR 6/2).

The B2 horizon ranges from strong brown (7.5YR 5/8) and reddish yellow (7.5YR 7/8 and 6/8) to light yellowish brown (10YR 6/4) and yellow (10YR 7/6). A B3 horizon, intermediate in color between the B2 and C1 horizons, is present in some places. Scattered chunks of weakly cemented ortstein are present in some places.

The C horizon ranges from very pale brown (10YR 7/3 or 7/4) to pinkish gray (7.5YR 7/2) or white (10YR 8/2). Faint to distinct mottling is below a depth of 24 inches in places that are moderately well drained.

Shelldrake soils are near Rubicon soils in most places. They have a lighter colored B horizon and have a higher percentage of quartz in the profile than Rubicon soils.

Shelldrake sand, 0 to 8 percent slopes (ShB).—This soil is in areas on beach ridges along the shores of Lake Superior.

Included with this soil in mapping, as distance from the lake increases, are a few areas of more strongly developed Rubicon soils. Also included are depressional areas that are moderately well drained, areas where the seasonal

high water table is within 3 feet of the surface in a few of the swales, and some areas where the slopes are more than 8 percent.

This soil is used for recreation and as woodland. Many summer cabins are on this soil. Because of the very rapid permeability of this soil, care should be taken to place septic systems so that water supplies are not polluted.

The major limitations to the use of this soil are low natural fertility, droughtiness, and the hazard of soil blowing. Capability unit VIIs–1 (5.3a); woodland suitability group 2s3; recreation group 1.

Skanee Series

The Skanee series consists of somewhat poorly drained, nearly level or gently sloping soils on till plains. These soils formed in dominantly loamy material.

In a representative profile the surface layer is black organic matter 3 inches thick. The subsurface layer is pinkish-gray sandy loam 5 inches thick. The upper part of the subsoil is mottled, dark reddish-brown, friable fine sandy loam 9 inches thick, the middle part is a fragipan that is mottled, reddish-brown, very firm sandy loam 4 inches thick, and the lower part is mottled, weak-red loamy sand and reddish-brown sandy loam 15 inches thick. The lower part of the subsoil is a very firm fragipan. The underlying material, at a depth of 33 inches, is reddish-brown sandy loam that grades to light reddish-brown light sandy loam at a depth of 40 inches. It extends to a depth of 60 inches or more.

Skanee soils have medium available water capacity above the fragipan and low available water capacity in the fragipan and underlying layers. Natural fertility is medium. Permeability is moderate above the fragipan and slow to moderately slow through the fragipan. The seasonal high water table fluctuates between depths of 1 foot and 2 feet during the year. Runoff is slow.

Skanee soils are used as woodland.

Representative profile of Skanee sandy loam, 0 to 6 percent slopes, in a wooded area, in the SE¼NE¼SE¼ sec. 31, T. 47 N., R. 18 W., Alger County:

O2—3 inches to 0, black (5YR 2/1) organic matter; weak, medium, granular structure; very friable; many roots; very strongly acid; abrupt, smooth boundary.

A2—0 to 5 inches, pinkish-gray (5YR 6/2) sandy loam; weak, medium, subangular blocky structure; friable; few roots; less than 2 percent coarse fragments; very strongly acid; abrupt, irregular boundary.

B21hir—5 to 9 inches, dark reddish-brown (5YR 3/2) fine sandy loam; few medium, faint, yellowish-red (5YR 4/8) mottles; weak, medium, subangular blocky structure; friable; many roots; 3 percent coarse fragments; very strongly acid; clear, wavy boundary.

B22ir—9 to 14 inches; dark reddish-brown (5YR 3/4) fine sandy loam; common, medium, distinct, yellowish-red (5YR 5/8) mottles around root channels; weak, medium, subangular blocky structure; friable; common roots; 3 percent coarse fragments; very strongly acid; abrupt, wavy boundary.

Bx—14 to 18 inches, reddish-brown (5YR 5/4) sandy loam; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; weak, thick, platy structure; very firm; few roots; 3 percent coarse fragments; very strongly acid; clear, broken boundary.

(B′&A′)x—18 to 33 inches, reddish-brown (5YR 4/4) sandy loam (B′) and weak-red (2.5YR 5/2) loamy sand (A′); A′ material makes up 15 to 20 percent, by volume, of the horizon; many, medium, distinct, yellowish-red (5YR 4/6) mottles; weak, thick, platy structure; very firm; thick clay films on faces of peds and in pores; 3 percent coarse fragments; very strongly acid; gradual, wavy boundary.

C1—33 to 40 inches, reddish-brown (2.5YR 5/4) sandy loam; massive; friable; 3 percent coarse fragments; strongly acid; clear, smooth boundary.

IIC2—40 to 60 inches, light reddish-brown (2.5YR 6/4) light sandy loam; massive; very friable; strongly acid.

The solum ranges from 30 to 50 inches in thickness. Reaction ranges from very strongly acid to medium acid throughout the solum.

In places a black (10YR 2/1) A1 horizon 1 inch to 2 inches thick is present. The A2 horizon is pinkish gray (5YR 6/2) or reddish gray (5YR 5/2).

The B21hir horizon has hue of 5YR, value of 2 or 3, and chroma of 2 to 4. The B22ir horizon is dark reddish brown (5YR 3/4) or reddish brown (5YR 4/4). The B3x horizon is reddish brown (5YR 5/4) or yellowish red (5YR 4/6). The fragipan in this horizon is not present in some places.

The A′ part of the (B′&A′)x horizon has hue of 10R to 5YR, value of 5 or 6, and chroma of 2 or 3. It is sandy loam or loamy sand. The B′ part of the (B′&A′)x horizon has hue of 10R to 5YR and value and chroma of 4. It is sandy loam, loam, or light sandy clay loam. The A′ part of the (B′&A′)x horizon makes up the outer part of peds, and the center part of the peds is B′ material. The fragipan is friable to firm when moist and hard when dry.

The C horizon has hue of 10R or 2.5YR, value of 4 or 5, and chroma of 4. It is sandy loam or light sandy loam and contains strata of loamy sand in a few places. The C horizon is strongly acid to medium acid in reaction.

Skanee soils, in most places, are near Kawbawgam and Munising soils. They differ from Kawbawgam soils in that they are deeper than 40 inches and have a fragipan. They have mottles in the B horizon, which Munising soils lack.

Skanee sandy loam, 0 to 6 percent slopes (SkB).—This soil is in depressional areas on till plains. Areas are small and scattered.

Included with this soil in mapping in higher areas are moderately well drained Munising soils. Also included are a few areas of soils that have slopes of more than 6 percent, and some areas where sandstone bedrock is below a depth of 4 feet.

This soil is used as woodland.

The fragipan in this soil reduces the effectiveness of tile drains by slowing the downward movement of water.

The major limitations to the use of this soil for crops are seasonal wetness, the hazard of frost, and presence of a fragipan. Capability unit IIwc–6 (3b–a); woodland suitability group 2o5; recreation group 8.

Steuben Series

The Steuben series consists of well drained and moderately well drained, nearly level to moderately steep soils on till plains and moraines. These soils formed in dominantly loamy material 20 to 40 inches thick over sandy material.

In a representative profile the surface layer is a black organic mat 2 inches thick. The subsurface layer is reddish-gray fine sandy loam 6 inches thick. The upper part of the subsoil is dark reddish-brown, friable fine sandy loam 8 inches thick, the middle part is dark-brown, friable fine sandy loam 5 inches thick, and the lower part is a fragipan of pinkish-gray firm loamy fine sand and reddish-brown firm fine sandy loam 19 inches thick (fig. 14). The underlying material is light-brown and brown sand that has some thin, reddish-brown bands in the upper part.

Steuben soils have moderate available water capacity above the fragipan and low available water capacity in the

fragipan. Natural fertility is medium. Permeability is moderate above the fragipan and slow to moderately slow through the fragipan.

Steuben soils are used mainly as woodland.

Representative profile of Steuben fine sandy loam, 0 to 6 percent slopes, in a wooded area, in the NE¼SW¼SW¼SE¼ sec. 8, T. 45 N., R. 20 W., Alger County:

O1—2 inches to 0, black (5YR 2/1) organic mat; very friable; many roots; very strongly acid; abrupt, smooth boundary.

A2—0 to 6 inches, reddish-gray (5YR 5/2) fine sandy loam; weak, coarse, platy structure; friable; less than 2 percent coarse fragments; very strongly acid; abrupt, wavy boundary.

B21hir—6 to 9 inches, dark reddish-brown (5YR 2/2) fine sandy loam; weak, medium and coarse, subangular blocky structure; friable; less than 2 percent coarse fragments; very strongly acid; clear, wavy boundary.

B22ir—9 to 14 inches, dark reddish-brown (5YR 3/4) fine sandy loam; weak, medium and coarse, subangular blocky structure; friable; less than 2 percent coarse fragments; very strongly acid; gradual, wavy boundary.

B23—14 to 19 inches, dark-brown (7.5YR 4/4) fine sandy loam; weak, medium and coarse, subangular blocky structure; friable; less than 2 percent coarse fragments; strongly acid; abrupt, smooth boundary.

B'x&A'x—19 to 38 inches, reddish-brown (2.5YR 4/4) fine sandy loam (B') and pinkish-gray (5YR 6/2 and 7/2) loamy fine sand (A'); B' part makes up 60 percent of the horizon, and A' part makes up 40 percent; weak, very thick, platy structure; hard and brittle when dry, firm when moist; few thin clay films; vesicular; 3 percent coarse fragments; strongly acid; abrupt, smooth boundary.

IIC1—38 to 43 inches, light-brown (7.5YR 6/4) sand; few reddish-brown (2.5YR 4/4) bands 1/16 to 1/4 inch thick; single grained; loose; strongly acid; abrupt, wavy boundary.

IIC2—43 to 60 inches, brown (7.5YR 5/4) sand and coarse sand; single grained; loose; medium acid.

The solum ranges from 20 to 40 inches in thickness, which corresponds to the depth to sandy material. Depth to the fragipan ranges from 17 to 26 inches. Reaction of the solum ranges from very strongly acid to medium acid.

A black (5YR 2/1 or 10YR 2/1) A1 horizon 1 to 2 inches thick is present in a few places. The A2 horizon has hue of 5YR or 7.5YR, value of 5, and chroma of 2.

The B21hir horizon has hue of 5YR, value of 2 or 3, and chroma of 2 or 3. It is sandy loam or fine sandy loam. The B22ir horizon has hue of 5YR, value of 3 or 4, and chroma of 4 or 6. It is sandy loam or fine sandy loam. The B23 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or fine sandy loam.

The B' part of the B'x&A'x horizon has hue of 2.5YR, value of 4 or 5, and chroma of 4. It ranges from sandy loam to light sandy clay loam. The A' part of the B'x&A'x horizon has hue of 5YR, value of 5 or 6, and chroma of 2 or 3. It is sand, loamy sand, or loamy fine sand. The A' part makes up 40 to 50 percent of the B'x&A'x horizon and is around peds of B' material. Clay films are in pores. The fragipan is friable to very firm when moist and hard or very hard when dry.

The IIC horizon has hue of 5YR to 7.5YR, value of 5 or 6, and chroma of 3 or 4. It is dominantly sand but has strata of coarse sand or fine gravel in a few places. The IIC horizon ranges from strongly acid to slightly acid in reaction.

The Steuben soils in most places are near Munising and Blue Lake soils. They have a coarser textured C horizon than Munising soils. They have a finer textured Bir horizon than Blue Lake soils, and they have a fragipan, which Blue Lake soils lack.

Steuben fine sandy loam, 0 to 6 percent slopes (StB).—This soil is in irregularly shaped areas on water-worked moraines and till plains. It has the profile described as representative of the series. Runoff is slow. The hazard of erosion is slight.

Figure 14.—**Profile of a Steuben fine sandy loam, showing a fragipan at a depth of about 18 to 32 inches.**

Included with this soil in mapping are small areas of Blue Lake, Kalkaska, Karlin, and Munising soils in Alger County. Also included are areas of Karlin and Trenary soils in Schoolcraft County. In Schoolcraft County there are areas of Steuben soils that have a fragipan that is thinner and weaker than that of this Stuben soil.

This soil is used mainly as woodland. Only a small acreage has been cleared. Except for a few garden plots, most of the cleared areas are idle. Some areas have been planted to red pine.

The major limitations to the use of this soil for crops are moderate droughtiness and the presence of a fragipan that restricts rooting of deep-rooted crops. Capability unit IIe-3 (3a-a); woodland suitability group 2d1; recreation group 4.

Steuben fine sandy loam, 6 to 18 percent slopes (StD).—This soil is in irregularly shaped areas on water-worked moraines. Runoff is slow because of the forest cover, but the hazard of erosion is severe.

Included with this soil in mapping are small areas of Blue Lake, Kalkaska, Karlin, and Munising soils. Also included are small areas of soils that have slopes of more than 18 percent.

This soil is used as woodland.

The major limitations to the use of this soil for crops are steepness, the hazard of erosion, and moderate

droughtiness. Capability unit IVe–4 (3a–a); woodland suitability group 2d1; recreation group 6.

Summerville Series

The Summerville series consists of well drained or moderately well drained, nearly level to moderately steep soils on shallow till plains or bedrock benches. These soils formed in loamy material 10 to 20 inches thick over limestone bedrock.

In a representative profile the surface layer is very dark gray fine sandy loam 4 inches thick. The subsurface layer is light brownish-gray fine sandy loam 3 inches thick. The subsoil is brown, friable fine sandy loam 4 inches thick. The underlying material is light reddish-brown fine sandy loam 4 inches thick over limestone bedrock.

Summerville soils have moderate available water capacity, but the shallow soil depth limits the amount of water stored in the soil and often results in droughtiness during extended dry periods. Natural fertility is medium. Permeability is moderate. Downward movement of water is not greatly slowed by the bedrock, because the bedrock is commonly fractured. Runoff is slow.

Summerville soils are used for hay and pasture and as woodland.

Representative profile of Summerville fine sandy loam, 0 to 4 percent slopes, in a wooded area, at the center of the SW¼NW¼NW¼ sec. 3, T. 38 N., R. 19 W., Delta County:

A1—0 to 4 inches, very dark gray (10YR 3/1) fine sandy loam; weak, fine, granular structure; friable; less than 2 percent coarse fragments; mildly alkaline; abrupt, smooth boundary.

A2—4 to 7 inches, light brownish-gray (10YR 6/2) fine sandy loam; weak, fine, subangular blocky structure; friable; less than 2 percent coarse fragments; mildly alkaline; abrupt, wavy boundary.

B2—7 to 11 inches, brown (7.5YR 4/4) fine sandy loam; weak, fine, subangular blocky structure; friable; less than 2 percent coarse fragments; mildly alkaline; clear, wavy boundary.

C—11 to 15 inches, light reddish-brown (5YR 6/4) fine sandy loam; weak, fine, subangular blocky structure; friable; 3 percent coarse fragments; strongly effervescent; moderately alkaline; abrupt, smooth boundary.

IIR—15 inches, limestone bedrock.

The thickness of the solum and depth to bedrock range from 10 to 20 inches. Reaction of the solum ranges from slightly acid to moderately alkaline.

In cultivated areas the Ap horizon is 4 to 8 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A1 horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 3. The A2 horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2 or 3. It is sandy loam or fine sandy loam.

The B2 horizon has hue of 5YR to 10YR, value of 3 or 4, and chroma of 3 or 4. It is sandy loam or fine sandy loam.

The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 2 to 4. It is mildly alkaline or moderately alkaline. In a few places a layer of weathered limestone 2 to 3 inches thick is present above the bedrock.

Summerville soils formed in materials similar to those in which Ensign and Longrie soils formed. They lack mottles in the B horizon, which are characteristic of Ensign soils. They have bedrock at a depth of 10 to 20 inches instead of at a depth of 20 to 40 inches, which is typical of Longrie soils.

Summerville fine sandy loam, 0 to 4 percent slopes (SuA).—This soil is on shallow till plains or bedrock benches. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping, mainly on the Garden Peninsula, are a few areas of Limestone rock land. In these areas the soil material is less than 10 inches thick. Also included are a few areas of Longrie soils and somewhat poorly drained Ensign soils. Some areas are very stony.

This soil is used mainly for hay and pasture and as woodland (fig. 15). Some areas are too stony for cultivation, and these areas are used for pasture.

The major limitations to the use of this soil are shallow soil depth, seasonal droughtiness, and stoniness. Capability unit VIs–3 (Ra); woodland suitability group 3d1; recreation group 12.

Sundell Series

The Sundell series consists of somewhat poorly drained, nearly level or gently sloping soils on shallow till plains and bedrock benches. These soils formed in loamy material 20 to 40 inches thick over limestone bedrock.

In a representative profile the surface layer is very dark gray fine sandy loam 8 inches thick. The upper part of the subsoil is mottled, yellowish-red, friable loam 9 inches thick, and the lower part is mottled, reddish-brown friable loam 6 inches thick. The underlying material is light-brown loam 3 inches thick over limestone bedrock.

Sundell soils have high available water capacity and high natural fertility. Permeability is moderate. The seasonal high water table is within a depth of 1 to 2 feet of the surface in spring and winter and drops to below the bedrock contact during summer. Runoff is slow.

Sundell soils are used for hay, pasture, and small grain or as woodland. They are used mainly as woodland.

Representative profile of Sundell fine sandy loam, 0 to 4 percent slopes, in a cultivated area, in the NW¼NW¼NW¼NE¼ sec. 12, T. 38 N., R. 22 W., Delta County:

Ap—0 to 8 inches, very dark gray (10YR 3/1) fine sandy loam; moderate, fine, granular structure; friable; less than 2 percent coarse fragments; slightly acid; abrupt, smooth boundary.

B2ir—8 to 17 inches, yellowish-red (5YR 4/6) loam; few, fine, faint, strong-brown (7.5YR 5/6) mottles; weak, fine, subangular blocky structure; friable; 2 percent coarse fragments; slightly acid; clear, wavy boundary.

B3—17 to 23 inches, reddish-brown (5YR 5/4) loam; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; weak, fine, subangular blocky structure; friable; 2 percent coarse fragments; mildly alkaline; gradual, wavy boundary.

C—23 to 26 inches, light-brown (7.5YR 6/4) loam; many, medium, distinct, strong-brown (7.5YR 5/8) and brownish-yellow (10YR 6/8) mottles; weak, fine, subangular blocky structure; friable; 3 percent coarse fragments; slightly effervescent; moderately alkaline; abrupt, smooth boundary.

IIR—26 inches, limestone bedrock.

The thickness of the solum is commonly 20 to 30 inches, and in places it corresponds to the depth to bedrock. Depth to bedrock ranges from 20 to 40 inches. Reaction of the solum ranges from slightly acid to mildly alkaline.

In undisturbed areas the A1 horizon is 3 to 6 inches thick. It has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. An A2 horizon as much as 6 inches thick is present in some places, and it has hue of 7.5YR and 10YR, value of 5 or 6, and chroma of 2 or 3. The Ap horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2.

The B2ir horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. It is fine sandy loam or loam. The B3

Figure 15.—A wooded area of Summerville fine sandy loam.

horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 or 4. It is fine sandy loam or loam.

The C horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 3 or 4. It is fine sandy loam or loam. A thick layer of weathered limestone 1 inch or 2 inches thick lies directly above the bedrock in some places.

Sundell soils in most places are near Ensign, Longrie, and Nahma soils. They have bedrock at a depth of 20 to 40 inches instead of at a depth of less than 20 inches, which is characteristic of Ensign soils. They have mottles in the B horizon, which Longrie soils lack. They lack an organic layer on the surface, which Nahma soils have; also, they generally have brighter colors in the B horizon than Nahma soils.

Sundell fine sandy loam, 0 to 4 percent slopes (Sv A).—This soil is on shallow till plains or bedrock benches.

Included with this soil in mapping are a few depressional areas of poorly drained Nahma or Ruse soils and low knolls of well drained or moderately well drained Longrie or Summerville soils. Also included, where this soil approaches the maximum depth of 40 inches, are a few small areas of Charlevoix soils. There are a few areas where the surface layer is loam.

Most of this soil is used as woodland. Cleared areas generally are used for hay, oats, and pasture, but some areas are idle.

Drainage by ditching removes excess water. Tiling is not generally practical, because of the shallow depth to bedrock.

The major limitations to the use of this soil for crops are seasonal wetness, shallow depth to bedrock, and the hazard of frost. Capability unit IIIwc–4 (3/Rbc); woodland suitability group 2o5; recreation group 8.

Sundell Series, Sandy Variant

The Sundell series, sandy variant, consists of somewhat poorly drained, nearly level or gently sloping soils on lake plains and on bedrock benches. These soils formed in sandy material 20 to 40 inches thick over limestone bedrock.

In a representative profile the surface layer is very dark gray loamy fine sand 9 inches thick. The subsurface layer is grayish-brown loamy fine sand 2 inches thick. The upper part of the subsoil is mottled, reddish-brown, friable loamy fine sand 11 inches thick, and the lower part is mottled, brown, very friable loamy fine sand 7 inches thick. The underlying material is yellowish-brown loamy fine sand 6 inches thick over limestone bedrock.

Sundell soils, sandy variant, have moderate available water capacity and low natural fertility. Permeability is rapid. The bedrock restricts downward movement of water. The seasonal high water table is within 1 to 2 feet of the surface to below the bedrock contact. Runoff is slow.

These soils are used for hay or pasture, are idle, or are used as woodland.

Representative profile of Sundell loamy fine sand, sandy variant, 0 to 4 percent slopes, in a cultivated area, in the SE¼SE¼SW¼ sec. 5, T. 38 N., R. 23 W., Delta County:

Ap—0 to 9 inches, very dark gray (10YR 3/1) loamy fine sand; weak, coarse, granular structure; very friable; neutral; abrupt, smooth boundary.

A2—9 to 11 inches, grayish-brown (10YR 5/2) loamy fine sand; weak, coarse, granular structure; very friable; neutral; abrupt, wavy boundary.

B2ir—11 to 22 inches, reddish-brown (5YR 4/4) loamy fine sand; common, coarse, faint, yellowish-red (5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; neutral; clear, smooth boundary.

B3—22 to 29 inches, brown (7.5YR 5/4) loamy fine sand; common, coarse, distinct, yellowish-red (5YR 5/6) mottles; very weak, fine, subangular blocky structure; very friable; neutral; gradual, smooth boundary.

C—29 to 35 inches, yellowish-brown (10YR 5/4) loamy fine sand; very weak, fine, subangular blocky structure; friable; mildly alkaline; abrupt, smooth boundary.

IIR—35 inches, limestone bedrock.

The solum ranges from 18 to 30 inches in thickness. The depth to bedrock ranges from 20 to 40 inches. Reaction of the entire profile ranges from slightly acid to mildly alkaline.

In undisturbed areas the A1 horizon is black (10YR 2/1) or dark reddish-brown (5YR 2/2) and is 1 to 3 inches thick. The A2 horizon is grayish brown (10YR 5/2) or light brownish gray (10YR 6/2). It is 4 to 8 inches thick in undisturbed areas.

The B2ir horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 4 or 6. The B3 horizon has hue of 7.5YR or 10YR, value of 5, and chroma of 4.

The C horizon is yellowish brown (10YR 5/4) or light yellowish brown (10YR 6/4). Thin strata of sand or loamy sand are present in some places.

Sundell soils, sandy variant, have drainage characteristics similar to those of Au Gres and Sundell soils. They have finer sand throughout the profile than Au Gres soils, and they have bedrock within a depth of 40 inches, which Au Gres soils lack. They are coarser textured throughout the profile than Sundell soils.

Sundell loamy fine sand, sandy variant, 0 to 4 percent slopes (SwA).—This soil is on lake plains and bedrock benches.

Included with this soil in mapping, where this soil approaches its maximum thickness, are a few areas of Au Gres soils. Also included are a few areas where the profile is sand.

This soil is used mainly as woodland. Cleared areas are used for hay or pasture.

Ditches remove excess water. Tiling generally is not practical, because of the presence of bedrock at a shallow depth.

The major limitations to the use of this soil for crops are seasonal wetness, shallow depth to bedrock, and low natural fertility. Capability unit IVwc–1 (4/Rbc); woodland suitability group 3s3; recreation group 8.

Tacoosh Series

The Tacoosh series consists of very poorly drained, nearly level or depressional soils on till plains. These soils formed in dominantly herbaceous organic material 16 to 51 inches thick over loamy material. Tacoosh soils are mapped only with Cathro soils in this survey area.

In a representative profile the surface layer is black muck (sapric material) 8 inches thick. The next layer is black mucky peat (hemic material) 12 inches thick. The next lower layer is dark reddish-brown mucky peat (hemic material) 14 inches thick. The next layer is very dark grayish-brown mucky peat (hemic material) 6 inches thick. The underlying material begins at a depth of 40 inches. The upper 2 inches of the underlying material is grayish-brown very fine sandy loam. Below this it is light brownish-gray sandy loam.

Tacoosh soils have very high available water capacity in the organic layers and moderate available water capacity in the underlying material. Natural fertility is low. Permeability is rapid in the organic layers and moderate in the underlying material. The seasonal high water table is at or near the surface most of the year, but it drops to a depth of 18 to 24 inches in some areas during extended dry periods. Runoff is slow or ponded.

These soils are used as woodland.

Representative profile of Tacoosh muck in an area of Cathro and Tacoosh mucks, in a wooded area, in the SE¼SE¼ sec. 8, T. 43 N., R. 23 W., Delta County:

Oa1—0 to 8 inches, black (10YR 2/1, broken face, rubbed and pressed) sapric material; about 20 percent fiber, 5 percent rubbed; weak, fine, granular structure; nonsticky; fibers are 75 percent herbaceous, 25 percent woody; slightly acid; clear, smooth boundary.

Oe1—8 to 20 inches, black (10YR 2/1, broken face, rubbed and pressed) hemic material; about 30 percent fiber; 15 percent rubbed; weak, medium, granular structure; nonsticky; fibers are 60 percent herbaceous, 40 percent woody; slightly acid; clear, smooth boundary.

Oe2—20 to 34 inches, dark reddish-brown (5YR 2/2), black (10YR 2/1, rubbed and pressed) hemic material; about 40 percent fiber, 20 percent rubbed; weak, medium, subangular blocky structure; nonsticky; fibers are 75 percent herbaceous, 25 percent woody; 15 percent mineral content; slightly acid; abrupt, smooth boundary.

Oe3—34 to 40 inches, very dark grayish-brown (10YR 3/2), very dark brown (10YR 2/2 rubbed), very dark grayish-brown (10YR 3/2 pressed) hemic material; about 60 percent fiber, 25 percent rubbed; massive; nonsticky; fibers are herbaceous; neutral; abrupt, smooth boundary.

IIC1g—40 to 42 inches, grayish-brown (2.5Y 5/2) very fine sandy loam; massive; slightly sticky; mildly alkaline; abrupt, smooth boundary.

IIC2g—42 to 60 inches, light brownish-gray (10YR 6/2) sandy loam; massive; slightly sticky; slightly effervescent; moderately alkaline.

The organic material ranges from 16 to 51 inches in thickness but most commonly is 20 to 40 inches thick. Reaction of the organic material ranges from medium acid to mildly alkaline. Most of the organic material is herbaceous, but as much as half of it is woody in some areas. Hemic material is dominant throughout the organic layers. Woody fragments are common in many areas.

The organic material on the broken face, when rubbed and pressed, has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 3. Individual thin layers of sapric or fibric material are in some areas.

The IIC1g horizon has hue of 7.5YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It ranges from loamy sand to loam. The IIC2g horizon has hue of 7.5YR to 5Y, value of 4 to 6, and chroma of 2 to 4. It is sandy loam or loam. The mineral horizons range from slightly acid to moderately alkaline in reaction.

Tacoosh soils are near Cathro, Chippeny, Carbondale, Lupton, and Rifle soils. They contain less sapric material than Cathro soils. They lack the limestone bedrock that underlies Chippeny soils. They have loamy material below a depth of 16 to 51 inches, which Carbondale, Lupton, and Rifle soils lack.

Tawas Series

The Tawas series consists of very poorly drained, nearly level or depressional soils on lake plains, outwash plains,

and till plains. These soils formed mainly in woody organic material 16 to 51 inches thick over sandy material.

In a representative profile the surface layer is very dark grayish-brown mucky peat (hemic material) 4 inches thick. The next layer is black muck (sapric material) 7 inches thick. The next layer is very dark gray muck (sapric material) 7 inches thick. The underlying material, at a depth of 18 inches, is dark grayish-brown sand.

Tawas soils have very high available water capacity in the organic layers and very low available water capacity in the underlying material. Natural fertility is low. Permeability is rapid in the organic layers and rapid in the underlying material. Downward movement of water is impeded by the seasonal high water table, which is at or near the surface most of the year. Runoff is very slow or ponded.

This soil is used as woodland and for wildlife habitat.

Representative profile of Tawas mucky peat, in a wooded area, 200 feet east of cabin, NW¼SW¼ sec. 21, T. 43 N., R. 19 W., Delta County:

Oe1—0 to 4 inches, very dark grayish-brown (10YR 3/2, broken face, rubbed and pressed) hemic material; about 70 percent fibers, 20 percent rubbed; weak, medium, granular structure; nonsticky; fibers are dominantly woody but a few are herbaceous; medium acid; abrupt, smooth boundary.

Oa1—4 to 11 inches, black (10YR 2/1, broken face, rubbed and pressed) sapric material; about 25 percent fiber, 5 percent rubbed; weak, medium, granular structure; nonsticky; fibers are dominantly woody but a few are herbaceous; medium acid; clear, wavy boundary.

Oa2—11 to 18 inches, very dark gray (10YR 3/1, broken face, rubbed and pressed) sapric material; about 15 percent fiber, less than 5 percent rubbed; weak, medium, granular structure; nonsticky; fibers are woody; few sand grains in lower 2 inches; slightly acid; abrupt, smooth boundary.

IIC—18 to 60 inches, dark grayish-brown (10YR 4/2) sand; single grained; nonsticky; slightly acid.

The organic material ranges from 16 to 51 inches in thickness but most commonly is about 18 to 36 inches thick. The reaction of the organic material ranges from medium acid to mildly alkaline. Most of the organic material is woody, but some herbaceous material generally is present.

The surface tier is either sapric or hemic material. The subsurface tier and the bottom tier, where present, are dominantly sapric material. Woody fragments in the form of twigs and roots are common in some areas. The organic material has hue of 2.5YR to 10YR, value of 2 or 3, and chroma of 1 to 3.

The IIC horizon is sand or loamy sand. It has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. A layer of mucky sand or mucky loamy sand 2 to 3 inches thick is present between the organic material and the mineral material in some areas. The mineral layers range from strongly acid to mildly alkaline in reaction.

Tawas soils are near Cathro, Dawson, Tacoosh, Carbondale, Lupton, and Rifle soils. They have a coarser textured IIC horizon than Cathro and Tacoosh soils. They are less acid throughout the profile than Dawson soils. They have sandy material between depths of 16 and 51 inches, which Carbondale, Lupton, and Rifle soils lack.

Tawas muck (0 to 2 percent slopes) (Ta).—This nearly level or depressional soil is on outwash plains, lake plains, and till plains and in narrow drainageways.

Included with this soil in mapping are a few areas of soils that have organic layers that are less decomposed than those in this Tawas soil; areas of Roscommon sand; and areas of soils that have an organic layer less than 16 inches thick. These included soils generally are around the edges of the mapped areas and are adjacent to better drained soils. Also included are areas of Carbondale, Lupton, or Rifle soils in some of the larger areas.

This soil is used as woodland and wildlife habitat.

The major limitations to the use of this soil are wetness and the hazard of frost. Capability unit VIIwc–5 (M/4c); woodland suitability group 5w2; recreation group 11.

Trenary Series

The Trenary series consists of well drained and moderately well drained, nearly level to moderately steep soils on till plains and moraines. These soils formed in loamy materials.

In a representative profile the surface layer is very dark gray fine sandy loam 3 inches thick. The subsurface layer is brown fine sandy loam 3 inches thick. The upper part of the subsoil is dark reddish-brown, friable fine sandy loam 6 inches thick. The next part of the subsoil is reddish-brown, friable fine sandy loam 5 inches thick. The next part of the subsoil is reddish-brown light sandy loam 9 inches thick; it is a weakly developed fragipan and is friable when moist and slightly hard when dry (fig. 16). The lower part of the subsoil is dark reddish-brown, firm sandy clay loam 11 inches thick. The underlying material is reddish-brown sandy loam that extends to a depth of 60 inches or more.

Trenary soils have moderate available water capacity and high natural fertility. Permeability is moderately slow.

Trenary soils respond well to good management and are suitable for all adapted crops. The soils are used for crops and as woodland.

Representative profile of Trenary fine sandy loam, 2 to 6 percent slopes, in a wooded area, in the NE¼NW¼NE¼ sec. 4, T. 43 N., R. 21 W., Delta County:

A1—0 to 3 inches, very dark gray (5YR 3/1) fine sandy loam; weak, medium, granular structure; friable; less than 2 percent coarse fragments; medium acid; abrupt, wavy boundary.

A2—3 to 6 inches, brown (7.5YR 5/2) fine sandy loam; weak, fine, subangular blocky structure; friable; less than 2 percent coarse fragments; medium acid; abrupt, wavy boundary.

B21ir—6 to 12 inches, dark reddish-brown (5YR 3/3) fine sandy loam; weak, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; strongly acid; clear, wavy boundary.

B22ir—12 to 17 inches, reddish-brown (5YR 4/4) fine sandy loam; moderate, medium, subangular blocky structure; friable; less than 2 percent coarse fragments; strongly acid; abrupt, irregular boundary.

A'2x—17 to 26 inches, reddish-brown (5YR 5/3) light sandy loam; weak, thick, platy structure; friable when moist, slightly hard when dry; vesicular; less than 2 percent coarse fragments; strongly acid; abrupt, irregular boundary.

B'2t—26 to 37 inches, dark reddish-brown (2.5YR 3/4) sandy clay loam; moderate, coarse, subangular blocky structure; firm; thin clay films on faces of peds; thin tongues of reddish-brown (5YR 5/3) A'2 material in upper part of horizon; less than 2 percent coarse fragments; medium acid; clear, wavy boundary.

C1—37 to 48 inches, reddish-brown (2.5YR 4/4) sandy loam; weak, medium, subangular blocky structure; friable; 2 percent coarse fragments; neutral; clear, wavy boundary.

C2—48 to 60 inches, reddish-brown (2.5YR 4/4) sandy loam; weak, medium, subangular blocky structure; friable; slightly effervescent; moderately alkaline.

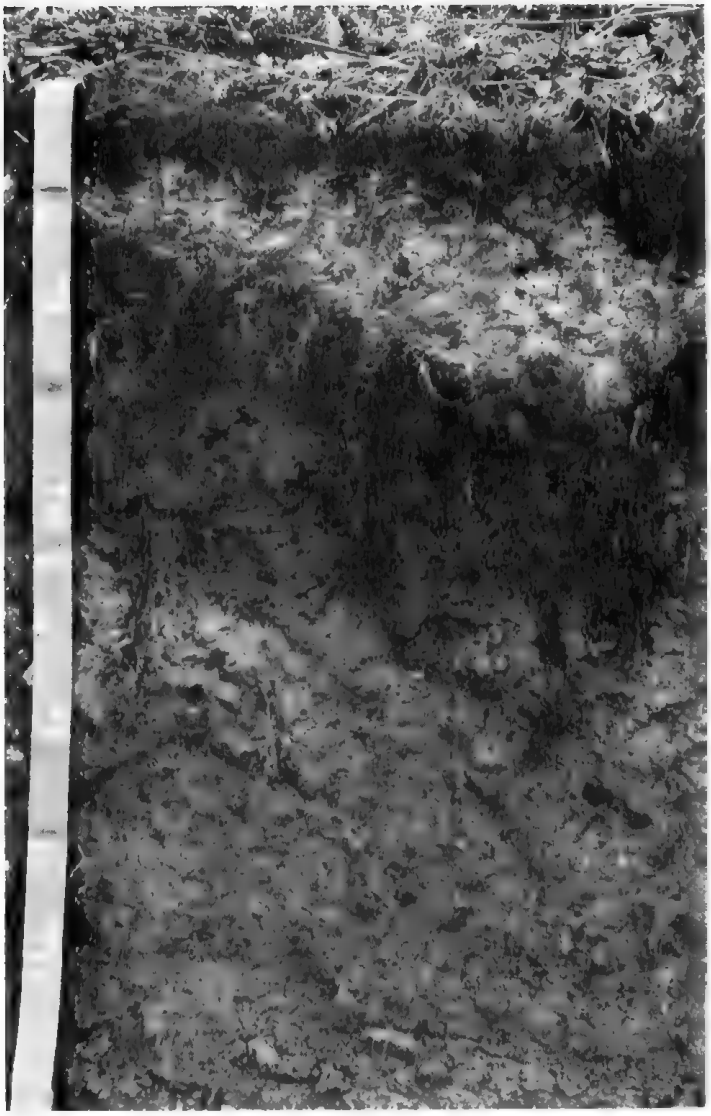

Figure 16.—**Profile of Trenary fine sandy loam.**

The solum ranges from 30 to 48 inches in thickness. Reaction in the solum is strongly acid to medium acid in the upper part and medium acid to slightly acid in the lower part. Limestone and sandstone stones and cobblestones are common throughout the profile in a few areas.

In cultivated areas, the A1 and A2 horizons have been mixed to form a dark-brown (7.5YR 3/2) plow layer 7 to 9 inches thick. The A1 horizon has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 1. The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. The B21ir horizon has hue of 2.5YR to 7.5YR, value of 2 to 4, and chroma of 2 to 4. The B22ir horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4 or 6.

The A'2x horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 to 4. It is light sandy loam or sandy loam. The A'2x horizon commonly extends into the B'2t horizon. The B'2t horizon has hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 4 or 6. It is loam or sandy clay loam.

The C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 2 or 3. It is sandy loam or loam. The C horizon is neutral to moderately alkaline in reaction. Lenses of sand and gravel are in the C horizon in a few places.

Trenary soils have a profile similar to that of Munising and Onaway soils. They are more alkaline in the C horizon than Munising soils, and they have a thinner, less developed fragipan. They differ from Onaway soils in having a solum more than 30 inches thick.

Trenary fine sandy loam, 0 to 2 percent slopes (TrA).—This soil is on till plains. Runoff is slow, and the hazard of erosion is slight. More acreage of this soil is moderately well drained than the more sloping Trenary soils.

Included with this soil in mapping are a few slightly depressional areas of somewhat poorly drained Charlevoix soils and areas where limestone bedrock is at a depth of about 4 to 6 feet. Also included near Chatham are areas of Trenary soils that are less red in color than are Trenary soils in Delta County.

This soil is used as woodland and for crops. It is well suited to all the crops commonly grown in the survey area. Potatoes, small grain, and hay are the main crops. This soil can be farmed intensively if fertility and organic-matter content are maintained.

Random tile is needed in a few areas of this soil to drain slight depressions. Capability unit IIe–2 (3a); woodland suitability group 2d1; recreation group 4.

Trenary fine sandy loam, 2 to 6 percent slopes (TrB).—This soil is on till plains and moraines. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are a few areas of somewhat poorly drained Charlevoix soils in depressions and drainageways and small areas of Longrie soils. Also included are areas of Karlin soils in Schoolcraft County; areas of Chatham soils near Chatham; and many areas where limestone bedrock is at a depth of 5 to 10 feet.

This soil is used for crops and as woodland. Potatoes, small grain, and hay are the main crops. This soil is well suited to all crops commonly grown in the survey area. Under intensive management that includes use of erosion control practices, row crops can be grown most of the time.

The major limitation to the use of this soil for crops is the hazard of erosion. Capability unit IIe–2 (3a); woodland suitability group 2d1; recreation group 4.

Trenary fine sandy loam, 6 to 12 percent slopes (TrC).—This soil is in small areas on till plains and moraines. Slopes are mostly short and uniform. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are a few small areas of Chatham soils in Alger County and some small areas where slopes are less than 6 percent or more than 12 percent. Also included, in some cultivated areas, are a few areas of moderately eroded soils.

This soil is used as woodland and for crops and pasture. This soil is productive and is suited to all crops commonly grown in the survey area. Farming on the contour, strip-cropping, and using grassed waterways help to control erosion in cultivated fields.

The major limitation to the use of this soil for crops is the hazard of erosion. Capability unit IIIe–5 (3a); woodland suitability group 2d1; recreation group 6.

Trenary fine sandy loam, 12 to 18 percent slopes (TrD). This soil has short slopes and is on moraines and till plains. Runoff is slow to rapid, depending on the kind and amount of plant cover. The hazard of erosion is severe. In Schoolcraft County, sand lenses 6 to 15 inches thick are in areas where this soil is near Karlin soils. Where

this soil has complex slopes, lenses of gravel are in the underlying material in a few places.

Included with this soil in mapping are areas of Chatham soils near Chatham. Also included are areas of Trenary soils that have slopes of less than 12 percent or more than 18 percent and some moderately eroded places in areas where this Trenary soil has been cultivated.

Most of this soil is used as woodland. Cleared areas are used mainly for pasture or are idle. Under intensive management, this soil can be used for crops, but most areas are small and are difficult to manage separately.

The major limitations to the use of this soil for crops are steepness and the hazard of erosion. This soil is somewhat more droughty than the less sloping Trenary soils. Capability unit IVe–4 (3a); woodland suitability group 2d1; recreation group 6.

Wainola Series

The Wainola series consists of somewhat poorly drained, nearly level or gently sloping soils on lake plains. These soils formed in sandy material.

In a representative profile the surface layer is undecomposed forest litter 2 inches thick. The subsurface layer is pinkish-gray fine sand 9 inches thick. The upper part of the subsoil is mottled, dark reddish-brown, friable fine sand 3 inches thick, the middle part is mottled, dark-brown, friable fine sand 3 inches thick, and the lower part is mottled, strong-brown, very friable fine sand 10 inches thick. The underlying material, at a depth of 24 inches, is reddish-brown fine sand that extends to a depth of 60 inches or more.

Wainola soils have low available water capacity and low natural fertility. Permeability is rapid. The seasonal high water table fluctuates between depths of 1 and 2 feet during the year. Runoff is slow.

Wainola soils are used mainly as woodland. Small areas have been cleared and are used for pasture.

Representative profile of Wainola fine sand, 0 to 4 percent slopes, in a wooded area, in the SE¼SW¼NW¼ sec. 15, T. 39 N., R. 23 W., Delta County:

O1—2 inches to 0, leaves and undecomposed forest litter.
A2—0 to 9 inches, pinkish-gray (7.5YR 7/2) fine sand; very weak, medium, subangular blocky structure; very friable; strongly acid; abrupt, wavy boundary.
B21ir—9 to 12 inches, dark reddish-brown (5YR 3/4) fine sand; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few weakly cemented chunks of ortstein; strongly acid; abrupt, broken boundary.
B22ir—12 to 15 inches, dark-brown (7.5YR 4/4) fine sand; common, fine, faint, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; friable; medium acid; clear, wavy boundary.
B3—15 to 24 inches, strong-brown (7.5YR 5/6) fine sand; common, fine, faint, strong-brown (7.5YR 5/8) mottles; very weak, medium, subangular blocky structure; very friable; medium acid; clear, wavy boundary.
C —24 to 60 inches, reddish-brown (5YR 5/3) fine sand; very weak, medium, subangular blocky structure; very friable; slightly acid.

The thickness of the solum ranges from 18 to 30 inches. Reaction of the solum ranges from strongly acid to slightly acid.

In a few places there is a black (10YR 2/1) A1 horizon as much as 2 inches thick. The A2 horizon has hue of 5YR or 7.5YR, value of 5 to 7, and chroma of 2.

The B21ir horizon is dark reddish brown (5YR 3/3 or 3/4). It is fine sand or loamy fine sand. The B22ir horizon is commonly reddish brown (5YR 4/4) or dark brown (7.5YR 4/4). It is fine sand or loamy fine sand.

The B3 horizon is commonly strong brown (7.5YR 5/6) or reddish brown (5YR 5/4). It is fine sand or loamy fine sand.

The C horizon is reddish brown (5YR 5/3) or light reddish brown (5YR 6/3). It is fine sand or loamy fine sand. The C horizon is medium acid to neutral in reaction.

Wainola soils that are medium acid in the C horizon are outside the range defined for the series. This difference does not affect the usefulness or behavior of these soils.

Wainola soils are similar to Au Gres and Rousseau soils. They have finer sand throughout the profile than Au Gres soils. They have mottles in the B horizon, which Rousseau soils lack.

Wainola fine sand, 0 to 4 percent slopes (WaA).—This soil is on lake plains.

Included with this soil in mapping are a few areas of Rousseau soils at higher elevations. Also included are a few areas of soils that have a surface layer of sand.

This soil is used mainly as woodland. Small areas have been cleared and are used for pasture.

Tile is difficult to install in this soil, because of the unstable fine sand. Sand flows into the tile unless the tile is blinded properly.

The major limitations to the use of this soil for crops are wetness, low fertility, and the hazard of frost. Capability unit IIIwc–5 (4b); woodland suitability group 3s3; recreation group 8.

Wallace Series

The Wallace series consists of well drained and moderately well drained, nearly level to moderately steep soils on outwash plains and old dunes. These soils formed in sandy material.

The surface layer is black, moderately decomposed forest litter 1 inch thick. The subsurface layer is gray sand 7 inches thick. The upper part of the subsoil is mottled, dark reddish-brown, strongly cemented sand 8 inches thick. The middle part of the subsoil is strong-brown, strongly cemented sand 6 inches thick. The lower part of the subsoil is brown sand 17 inches thick. It is weakly cemented at the top, becoming loose below a depth of 30 inches. The underlying material is light-brown sand.

Wallace soils have very low available water capacity and low natural fertility. Permeability is moderately slow in the cemented layers and rapid in the rest of the profile.

These soils are used as woodland.

Representative profile of Wallace sand, 6 to 18 percent slopes, in a wooded area, in the SE¼NE¼ sec. 22, T. 41 N., R. 20 W., Delta County:

O1—1 inch to 0, black (5YR 2/1) moderately decomposed forest litter; strongly acid; abrupt, smooth boundary.
A2—0 to 7 inches, gray (5YR 6/1) sand; single grained; loose; very strongly acid; abrupt, irregular boundary.
B21hirm—7 to 15 inches, dark reddish-brown (5YR 2/2) sand that has yellowish-red (5YR 4/6) and brown (7.5YR 5/4) streaks; massive; strongly cemented ortstein; strongly acid; clear, irregular boundary.
B22irm—15 to 21 inches, strong-brown (7.5YR 5/6) sand; massive; strongly cemented ortstein; medium acid; clear, wavy boundary.

B31—21 to 30 inches, brown (7.5YR 5/4) sand; massive; weakly cemented ortstein; slightly acid; gradual, smooth boundary.
B32—30 to 38 inches, brown (7.5YR 5/4) sand; single grained; loose; slightly acid; gradual, wavy boundary.
C—38 to 60 inches, light-brown (7.5YR 6/4) sand; single grained; loose; slightly acid.

The solum ranges from 28 to 46 inches in thickness. Reaction of the solum is very strongly acid or strongly acid.

In a few places a black (10YR 2/1 or N 2/0) A1 horizon, 1 to 2 inches thick, is below the 01 horizon. The thickness and color of the A2 and B horizons vary greatly within short horizontal distances. The A2 and B horizons extend into lower horizons as tongues and streaks, and follow old root channels. The A2 horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2.

The B21hirm horizon has hue of 5YR, value of 2 or 3, and chroma of 2 to 4. It is streaked with many closely related colors. The B22irm horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 or 6.

The B3 horizon has hue of 5YR or 7.5YR, value of 5, and chroma of 4 to 8. Cementation in the B horizon is weak to strong.

The C horizon has hue of 7.5YR, value of 5 or 6, and chroma of 4. It is medium acid or slightly acid in reaction.

Wallace soils in most places are near Kalkaska soils. They have a B horizon that is continuously cemented, unlike that of Kalkaska soils.

Wallace sand, 0 to 6 percent slopes (WlB).—This soil is on outwash plains and low dunes. It generally is near swamp borders. Surface runoff is slow. The hazard of soil blowing is severe. Included in mapping are a few small areas of Kalkaska soils in which the subsoil is not cemented.

This soil is used as woodland.

The major limitations to the use of this soil are low natural fertility, droughtiness, and a restricted root zone. Capability unit VIIs–1 (5a–h); woodland suitability group 2s3; recreation group 1.

Wallace sand, 6 to 18 percent slopes (WlD).—This soil is on old dunes and along swamp borders. It has the profile described as representative of the series. Runoff is slow or medium. The hazard of soil blowing is severe.

Included with this soil in mapping are a few areas of Kalkaska soils in which the subsoil is not cemented. Also included are a few areas of Wallace soils that have slopes of more than 18 percent.

This soil is used as woodland.

The major limitations to the use of this soil are low natural fertility, droughtiness, a restricted root zone, and the hazard of erosion. Capability unit VIIs–1 (5a–h); woodland suitability group 2s3; recreation group 3.

Wheatley Series

The Wheatley series consists of poorly drained, nearly level soils on outwash plains and lake plains. These soils formed in sandy material 15 to 40 inches thick over gravelly and sandy material.

In a representative profile the surface layer is black mucky loamy sand 5 inches thick. The upper part of the underlying material is grayish-brown sand 9 inches thick, the next part is mottled, grayish-brown sand 10 inches thick, the next part is dark grayish-brown sand 10 inches thick, and the lower part is olive-gray sand and gravel.

Wheatley soils have very low available water capacity and low natural fertility. Permeability is rapid. The seasonal high water table is within 12 inches of the surface most of the year but drops to a depth of 24 to 30 inches late in summer. Runoff is very slow or ponded.

Wheatley soils are used as woodland. A few cleared areas are idle.

Representative profile of Wheatley mucky loamy sand, from a wooded area, at the center of the NE¼ sec. 16, T. 38 N., R. 19 W., Delta County:

A1—0 to 5 inches, black (10YR 2/1) mucky loamy sand; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.
C1—5 to 14 inches, grayish-brown (2.5Y 5/2) sand; single grained; loose; slightly acid; clear, wavy boundary.
C2—14 to 24 inches, grayish-brown (10YR 5/2) sand; common, coarse, faint, yellowish-brown (10YR 5/4) mottles; single grained; loose; neutral; abrupt, wavy boundary.
C3—24 to 34 inches, dark grayish-brown (2.5Y 4/2) sand; single grained; loose; mildly alkaline; abrupt, smooth boundary.
IIC4—34 to 60 inches, olive-gray (5Y 5/2) stratified sand and gravel; single grained; loose; strongly effervescent; moderately alkaline.

The depth to the stratified sand and gravel ranges from 15 to 40 inches Reaction is slightly acid or neutral.

In cultivated areas there is a very dark gray (10YR 3/1) Ap horizon 6 to 9 inches thick. The A1 horizon is black (10YR 2/1 or 5YR 2/1).

The C1 horizon is grayish-brown (10YR 5/2 or 2.5Y 5/2) sand or loamy sand. The C2 horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2. It is sand or loamy sand. The C3 horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The IIC4 horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 2. It is stratified sand and gravel, or it is gravel.

Wheatley soils are in positions similar to those of Roscommon soils. Wheatley soils contain gravel in the lower part of the profile, which Roscommon soils lack.

Wheatley mucky loamy sand (0 to 2 percent slopes) (Wm).—This soil is on outwash plains and lake plains. Included with this soil in mapping are a few areas of soils that contain limestone slabs in the profile, but most areas are not stony. Also included are a few areas of Roscommon and Tawas soils, a few areas where as much as 12 inches of muck is on the surface, and a few areas where the surface layer is sandy loam.

This soil is used as woodland or is idle. Drainage is required for cultivated crops. Not all areas have adequate tile outlets. Tile is difficult to install, because trenches cave in. Ditching can be used to remove enough water so that oats and hay can be grown.

The major limitations to the use of this soil for crops are poor natural drainage, low natural fertility, and the hazard of frost.

This soil is a potential source of gravel. Excavation is difficult because of the high water table. Capability unit IIIwc–6 (5c); woodland suitability group 5w1; recreation group 10.

Yalmer Series

The Yalmer series consists of well drained and moderately well drained, nearly level to moderately steep soils on till plains and moraines. These soils formed in a layer of sandy material 20 to 40 inches thick over loamy material.

In a representative profile the surface layer is a black organic mat 2 inches thick. The subsurface layer is reddish-gray sand 7 inches thick. The upper part of the subsoil is dark reddish-brown, very friable sand 7 inches thick. The

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next part of the subsoil is reddish-brown, very friable sand 6 inches thick. The next lower part of the subsoil is yellowish-red, very friable sand 4 inches thick. The next part of the subsoil is light reddish-brown, light sandy loam and reddish-brown sandy loam 12 inches thick. This part is a fragipan that is friable when moist and hard when dry. The lower part of the subsoil is reddish-brown, friable sandy loam 5 inches thick. The underlying material, at a depth of 41 inches, is reddish-brown sandy loam.

Yalmer soils have low available water capacity above the fragipan layer. Roots of most plants are excluded from the fragipan and underlying layers, so water is not available to them. Natural fertility is low. Permeability is rapid in the sandy layers above the fragipan and slow to moderately slow through the fragipan.

This soil is used as woodland.

Representative profile of Yalmer sand, 0 to 6 percent slopes, in a wooded area, in the NW¼NE¼SW¼ sec. 3, T. 46 N., R. 20 W., Alger County:

O2—2 inches to 0, black (4YR 2/1) organic mat; very friable; strongly acid; abrupt, smooth boundary.

A2—0 to 7 inches, reddish-gray (5YR 5/2) sand; very weak, medium, subangular blocky structure; very friable; strongly acid; abrupt, wavy boundary.

B21hir—7 to 14 inches, dark reddish-brown (5YR 3/3) sand; very weak, medium, subangular blocky structure; very friable; strongly acid; clear, wavy boundary.

B22ir—14 to 20 inches, reddish-brown (5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; strongly acid; gradual, wavy boundary.

B23—20 to 24 inches, yellowish-red (5YR 5/6) sand; very weak, medium, subangular blocky structure; very friable; strongly acid; clear, wavy boundary.

IIA'x&B'x—24 to 36 inches, light reddish-brown (5YR 6/3) light sandy loam (A') and reddish-brown (2.5YR 4/4) sandy loam (B'); common, fine, distinct, yellowish-red (5YR 5/6) mottles; weak, coarse, platy structure; common clay bridging between sand grains in the reddish-brown material; friable when moist, hard when dry; vesicular; 2 percent coarse fragments; strongly acid; gradual, wavy boundary.

IIB'22—36 to 41 inches, reddish-brown (2.5YR 4/4) sandy loam; weak, medium, subangular blocky structure; friable; 2 percent coarse fragments; strongly acid; clear, wavy boundary.

IIC—41 to 60 inches, reddish-brown (2.5YR 5/4) sandy loam; common, fine, distinct, yellowish-red (5YR 5/6) mottles; massive; friable; 3 percent coarse fragments; medium acid.

The solum ranges from 24 to 50 inches in thickness. The thickness of the sandy horizons ranges from 20 to 40 inches, which commonly is the same as the depth to the fragipan. Reaction throughout the solum is strongly acid to medium acid.

A black (5YR 2/1) A1 horizon 1 to 2 inches thick is present in a few places. The A2 horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 2.

The B21hir horizon is dark reddish-brown (5YR 2/2, 3/3, or 3/4) sand or loamy sand. The B22ir horizon has hue of 2.5YR to 7.5YR, value of 2 to 4, and chroma of 4 to 6. It is sand or loamy sand. The B23 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is sand or loamy sand. In a few places a weak fragipan is in the lower part of the B23 horizon. The fragipan ranges from weak to strong in development, and it commonly formed in a IIA'x&B'x horizon in which the A' part and B' part each make up about 50 percent of the horizon. The A' part of the IIA'x&B'x horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 2 to 4. It is loamy sand or sandy loam. The B' part of the IIA'x&B'x horizon has hue of 10R to 5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or loam. The IIB'22 horizon has hue of 10YR to 5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or loam. The IIC horizon has hue of 10R to 5YR, value of 4 or 5, and chroma of 3 or 4. The mottles described in the IIC horizon in the representative profile are not present in all places. The IIC horizon is strongly acid to medium acid in reaction.

Yalmer soils in most places are near Blue Lake, Kalkaska, and Munising soils. They have a loamy C horizon and a fragipan in the A'&B' horizon, which Blue Lake soils do not have. They have loamy IIB' and IIC horizons, which Kalkaska soils lack. They have coarser textured A, Bh, and Bir horizons than Munising soils.

Yalmer sand, 0 to 6 percent slopes (YaB).—This soil is on till plains and moraines. It has the profile described as representative of the series. Runoff is slow. Soil blowing is a hazard if the soil is exposed.

Included with this soil in mapping are a few areas of Blue Lake, Kalkaska, or Munising soils. Also included are a few areas where sandstone bedrock or sand is below a depth of 60 inches and a few areas where the surface layer is loamy sand.

This soil is used as woodland.

The major limitations to the use of this soil for crops are droughtiness and low natural fertility. Capability unit IIIs-4 (4a-a); woodland suitability group 2s1; recreation group 2.

Yalmer sand, 6 to 18 percent slopes (YaD).—This soil is on till plains and moraines. Runoff is slow because this soil is wooded. The hazard of erosion is severe.

Included with this soil in mapping are a few areas of Kalkaska, Munising, and Blue Lake soils. Also included are some areas where the surface layer is loamy sand.

This soil is used as woodland.

The major limitations to the use of this soil for crops are droughtiness, steepness, and the hazard of erosion. Capability unit IVe-9 (4a-a); woodland suitability group 2s1; recreation group 3.

Use and Management of the Soils

Only a small acreage of the soils of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties is used for crops and pasture. This section explains the system of capability classification used by the Soil Conservation Service and describes management of the soils by capability units. In addition, predicted average acre yields of the principal crops grown in the survey area are given, and management of the soils for woodland, wildlife, recreation, and engineering purposes are described.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limi-

tations of groups of soils for recreation, for forest trees, or in engineering.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils (none in the survey area) have few limitations that restrict their use.
Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
Class V soils (none in the survey area) are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, woodland, or wildlife.
Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.
Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.
Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, although they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe 1 or IIIwc–2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass. In this survey area the Arabic numerals are not consecutive, because not all the capability units used in Michigan are represented in the survey area.

The capability classification of the soils in Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties is given in the "Guide to Mapping Units" at the end of this survey. For a complete explanation of the capability classification see *Land Capability Classification, Agriculture Handbook No. 210* (*8*).

In this soil survey, symbols made up of Arabic numerals and small or capital letters in parentheses follow the symbols of each capability unit. These symbols in parentheses identify the management group or groups, all or portions of which are represented by the soils in that capability unit. These management groups are part of a statewide system used by the Cooperative Extension Service in Michigan for making recommendations about applications of fertilizer, about drainage, and about other practices. For an explanation of this classification, refer to *Fertilizer Recommendations for Michigan Vegetables and Field Crops* (*3*).

Management by capability units

This subsection describes the soils in each capability unit, tells of their use and suitability for crops and pasture, and discusses management practices. The names of soil series represented in a capability unit are named in the description of the capability unit, but this does not mean that all the soils of a given series appear in the unit. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

Frost is a hazard on the wet depressional soils of the survey area. The average number of frost-free days ranges from 80 days in the extreme northwestern part of Delta County to 140 days near Lake Michigan and Lake Superior (*4*). The lower depressional areas in which the poorly drained soils are located, however, generally receive frost later in spring and earlier in fall than is indicated by the average number of frost-free days.

A lack of adequate drainage outlets is also a major concern of management on the wet soils of the survey area. The area lacks an adequate system of ditches to carry off excess water. Bedrock near the surface in some areas limits ditch depth.

CAPABILITY UNIT IIe-1 (1.5a)

Nester silt loam, 2 to 6 percent slopes, is the only soil in this unit. This well drained or moderately well drained soil has a surface layer of silt loam and a subsoil of silty clay loam. It is underlain by silty clay loam.

Available water capacity is high, and fertility is high. Permeability is moderately slow. Runoff is generally slow, and the hazard of erosion is slight.

This soil is sticky when wet. Tillage needs to be done at proper moisture content to maintain soil structure. Adding organic matter and restricting grazing during wet periods help to maintain soil structure. The major management needs are maintenance of organic-matter content, maintenance of good soil tilth, and control of erosion on the steeper areas.

This soil is used mainly for hay and pasture. It is well suited to most adapted crops except potatoes. It is well suited to pasture.

CAPABILITY UNIT IIe-2 (2.5a, 3a)

This unit consists of nearly level or gently sloping, well drained or moderately well drained soils of the Onaway and Trenary series (fig. 17). These soils have a surface layer of

Figure 17.—**Contour stripcropping in areas of Onaway and Trenary soils, in capability unit IIe–2 (2.5a, 3a).**

fine sandy loam and a subsoil of fine sandy loam to clay loam. They are underlain by sandy loam or loam.

Available water capacity is moderate or high. Fertility is high. Permeability is moderate to moderately slow. Runoff is slow, and the hazard of erosion is slight to moderate.

These soils are easy to work. The gently sloping areas warm up rapidly in spring. In places a few of the nearly level, moderately well drained areas need random tile drainage to realize full potential of the soil. The major management needs are maintenance of organic-matter content and control of erosion. Onaway soils have a thin subsoil in many areas, and crops do not grow well if the soil is moderately eroded.

These soils are used for potatoes, hay, small grain, pasture, and woodland. The soils are well suited to all adapted crops, to pasture, and to woodland.

CAPABILITY UNIT IIe–3 (2.5a, 3a, 3a–a)

This unit consists of deep, nearly level or gently sloping, well drained or moderately well drained soils of the Bohemian, Chatham, Emmet, Munising, and Steuben series. These soils have a surface layer of sandy loam or fine sandy loam. The subsoil is dominantly sandy loam to silt loam, but it ranges from loamy sand to light sandy clay loam. The underlying material ranges from sand to silt loam. Munising and Steuben soils have a fragipan in the lower part of the subsoil.

Available water capacity is moderate to high in the surface layer and the subsoil and moderate to low in the underlying material. Fertility is medium. Permeability is dominantly moderate to moderately rapid. Munising and Steuben soils have moderately slow to slow permeability in the fragipan. Runoff is slow, and the hazard of erosion is slight.

These soils are easy to work. Most of these soils dry out rapidly in spring, but Munising and Steuben soils dry out somewhat slower because of reduced permeability in the fragipan. A few of the nearly level, moderately well drained areas benefit from random tile drains where high-value crops are grown. These soils tend to be slightly droughty. The major management needs are control of erosion and maintenance of organic-matter content and fertility.

These soils are used mainly as woodland and for hay, pasture, and small grain. They are suited to all crops commonly grown in the survey area and to pasture.

CAPABILITY UNIT IIwc–2 (1.5b)

This unit consists of deep, nearly level or gently sloping, somewhat poorly drained soils of the Bowers and Kawkawlin series. These soils have a surface layer of silt loam and

a subsoil of silty clay loam or clay loam. They are underlain by clay loam or stratified silt to silty clay.

Available water capacity is high. Fertility is high. Permeability is moderately slow. The frost hazard is slight in some lower lying areas. The hazard of erosion is slight.

These soils are sticky when wet. Tillage needs to be done at the proper moisture content to maintain soil structure. Adding organic matter and restricting grazing during wet periods help to maintain soil structure. These soils warm up slowly in spring and dry out slowly unless they are drained. Water stands for short periods on nearly level areas after heavy rains. Surface drainage is needed to insure good pasture and hay. Most areas need tile drainage for more intensive uses.

These soils are used for pasture, hay, and some small grain. If these soils are adequately drained, they are suited to most commonly grown crops except potatoes. They are well suited to pasture.

CAPABILITY UNIT IIwc-6 (2.5b, 2.5c, 3b, 3c, 3b-a)

This unit consists of deep, nearly level or gently sloping, somewhat poorly drained soils of the Brimley, Charlevoix, and Skanee series and of nearly level, poorly drained soils of the Angelica, Bruce, coarse variant, and Ensley series. These soils have a surface layer that ranges from sandy loam to loam and a subsoil that ranges from loamy sand to light sandy clay loam. The underlying material ranges from loamy very fine sand to silt loam. Skanee soils have a fragipan.

Available water capacity is moderate to high. Fertility is medium to high. Permeability is moderate in most of the soils, but it is moderately slow in Angelica soils and is moderately slow to slow in the fragipan of the Skanee soils. The hazard of erosion is slight.

These soils warm up slowly in spring because of wetness. Water stands for long periods on the poorly drained soils. Surface drainage is needed for best growth of hay and pasture. Grazing needs to be restricted during wet periods. Drainage is the major concern of management on these soils. Even if tile drainage is used, these soils are not suited to all adapted crops because of the hazard of frost, especially near the interior of the survey area. Many areas lack suitable outlets for tile drains.

These soils are used mainly as woodland, but small areas are used for hay or pasture. If adequately drained, the soils are better suited to hay, pasture, or small grain than to most other uses.

CAPABILITY UNIT IIs-1 (1.5a)

Nester silt loam, 0 to 2 percent slopes, is the only soil in this unit. This well drained or moderately well drained soil has a surface layer of silt loam and a subsoil of silty clay loam. It is underlain by silty clay loam.

Available water capacity is high. Fertility is high. Permeability is moderately slow. Runoff is slow, and the hazard of erosion is slight.

This soil is sticky when wet. Tillage needs to be done at proper moisture content to maintain soil structure. Adding organic matter and restricting grazing during wet periods help to maintain soil structure. Some of the lower, moderately well drained areas in this unit benefit from tile drainage, especially where legumes or high-value crops are to be grown. The major management needs are maintenance of organic-matter content and good tilth.

This soil is mainly used for hay and pasture. It is well suited to most crops adapted to the area, but it is not suited to potatoes. It is well suited to pasture.

CAPABILITY UNIT IIs-2 (3a)

This unit consists of deep, nearly level, well drained or moderately well drained soils of the Chatham and Emmet series. These soils have a surface layer of sandy loam or fine sandy loam and a subsoil of sandy loam or light sandy clay loam. They are underlain by gravelly loamy sand or sandy loam.

Available water capacity generally is moderate, but it is low in the underlying material of Chatham soils. Fertility is medium. Permeability is moderate in Emmet soils and moderately rapid in Chatham soils. Runoff is slow, and the hazard of erosion is slight.

These soils are easy to work. A few depressional areas benefit from random tile drainage, especially where high-value crops are grown. The major management needs are maintenance of organic matter and fertility. These soils tend to be slightly droughty.

These soils are used for adapted crops, pasture, and woodland, to which they are well suited.

CAPABILITY UNIT IIIe-5 (2.5a, 3a)

This unit consists of deep, sloping, well-drained soils of the Onaway and Trenary series. These soils have a surface layer of fine sandy loam and a subsoil of sandy loam to clay loam. They are underlain by sandy loam or loam.

Available water capacity is moderate to high. Fertility is high. Permeability is moderate to moderately slow. Runoff is slow to medium, depending on the amount and kind of plant cover. The hazard of erosion is moderate.

These soils are easy to work. The major management needs are control of erosion and maintenance of organic matter. If these soils are used for crops, including grasses and legumes in the cropping system, stripcropping, and keeping tillage to a minimum are practices that are needed to reduce runoff. Waterways need to be grassed to prevent gullying. Some of these soils have short, complex slopes, which makes it difficult to lay out strips.

These soils are used for crops, hay, and pasture and as woodland. If conservation cropping systems are used, the soils are generally suited to most adapted crops. These soils are well suited to pasture.

CAPABILITY UNIT IIIe-6 (3a)

This unit consists of deep, sloping to moderately steep, well-drained soils of the Chatham and Emmet series. These soils have a surface layer of fine sandy loam or sandy loam and a subsoil of sandy loam to light sandy clay loam. They are underlain by sandy loam or gravelly loamy sand.

Available water capacity is generally moderate, but it is low in the underlying material of Chatham soils. Fertility is medium. Permeability is moderate in Emmet soils and moderately rapid in Chatham soils. Runoff is slow to rapid, depending on the plant cover. The hazard of erosion is moderate to severe.

These soils are easy to work. They tend to be slightly droughty. The major management needs are control of erosion and maintenance of organic-matter content and

fertility. Including grasses and legumes in the cropping system, stripcropping, and keeping tillage to a minimum are practices that are needed to reduce runoff. Waterways need to be grassed to prevent gullying.

These soils are used for crops and pasture and as woodland. If conservation cropping systems are used, the soils are generally suited to most adapted crops. Soils that have slopes of more than 12 percent are not suited to row crops. These soils are well suited to pasture.

CAPABILITY UNIT IIIe-8 (2/Ra, 3/Ra, 4/Ra)

This unit consists of moderately deep, nearly level or gently sloping, well drained or moderately well drained soils of the Fairport, Longrie, Onota, and Deerton series. Except for the Deerton soils, these soils have a surface layer of sandy loam or silt loam and a subsoil of dominantly sandy loam to clay loam. The Deerton soils have a surface layer of sand and a subsoil of sand or loamy sand. All the soils in this unit are underlain by bedrock at a depth of 20 to 40 inches.

Available water capacity generally is moderate to high, but it is low in Deerton soils. Fertility generally is medium to high, but it is low in Deerton soils. Permeability generally is moderate to moderately slow, but it is rapid in Deerton soils. Runoff generally is slow, but it increases to medium on the steeper slopes of the Fairport soils. The hazard of erosion is slight. The hazard of soil blowing is severe on Deerton soils.

Most of these soils are easy to work. Fairport soils are sticky when wet. Deerton soils are droughty. The other soils in this unit are somewhat droughty where the depth to bedrock approaches 20 inches. The major management needs are control of erosion and maintenance of organic-matter content and fertility.

Fairport and Longrie soils are used for crops and pasture and as woodland. Onota and Deerton soils are used as woodland. Fairport, Longrie, and Onota soils are suitable for most adapted crops, for pasture, and for use as woodland. Deerton soils are poorly suited to cultivated crops.

CAPABILITY UNIT IIIwc-1 (1c)

Pickford silt loam is the only soil in this unit. This deep, nearly level, poorly drained soil has a surface layer of silt loam. The subsoil mainly is silty clay, and the underlying material is silty clay.

Available water capacity and fertility are high. Permeability is very slow. The hazard of erosion is slight.

This soil is sticky when wet. It warms up slowly in spring. Water stands on the surface for extended periods. Surface drainage is needed to ensure good growth of hay and pasture crops. Grazing needs to be restricted during wet periods. The major management needs are drainage and maintenance of tilth. Even if this soil is adequately drained, the hazard of frost is a limitation to use for cultivated crops. Some areas lack suitable drainage outlets.

This soil is used mainly as woodland. It is better suited to pasture than to most other uses, but the kinds of forage plants that can be grown depend on the amount of drainage provided.

CAPABILITY UNIT IIIwc-2 (1b, 1c)

This unit consists of deep, nearly level or gently sloping, somewhat poorly drained and poorly drained soils of the Pickford series, moderately wet, and the Pickford series. These soils have a surface layer of silt loam and a subsoil of silty clay. They are underlain by silty clay.

Available water capacity is high. Fertility is high. Permeability is very slow. The hazard of erosion is slight. There is a hazard of frost in the lower lying areas of these soils.

These soils are sticky when wet. They warm up slowly in spring. Water stands on the surface of the Pickford soils for long periods. Surface drainage is needed to ensure good growth of hay and pasture crops. Grazing needs to be restricted during wet periods. The major management needs are drainage and maintenance of tilth. Some areas lack suitable drainage outlets.

The Pickford soils, moderately wet, are used for hay, small grain, and pasture and as woodland. The soils in the Pickford series are used as woodland. The soils in this unit are better suited to hay and pasture than to most other uses. The kinds of forage plants that can be grown depend on the amount of drainage provided.

CAPABILITY UNIT IIIwc-4 (3/Rbc)

This unit consists of moderately deep, nearly level to sloping, somewhat poorly drained or poorly drained soils of the Kawbawgam, Nahma, and Sundell series. These soils have a surface layer of sandy loam to loam and a subsoil of sandy loam to loam. They are underlain by bedrock at a depth of 20 to 40 inches.

Available water capacity is moderate to high. Fertility is medium to high. Permeability is moderate. There is a hazard of frost in the lower lying areas of these soils. The hazard of erosion is slight.

Water stands on the Nahma soils for long periods. Drainage is needed for best growth of pasture and hay crops. Tile drainage is generally not practical, because of the depth to bedrock.

These soils are used mainly as woodland. Some areas of the Sundell soils are used for hay, pasture, and small grain. These soils are better suited to hay and pasture than to most other uses.

CAPABILITY UNIT IIIwc-5 (4b)

This unit consists of deep, nearly level or gently sloping, somewhat poorly drained soils of the Au Gres, gravelly subsoil variant, Otisco, and Wainola series. These soils have a surface layer of loamy sand or fine sand and a subsoil of sand to fine sandy loam. They are underlain by sand and gravel, sand, or fine sand.

Available water capacity is low. Fertility is low. Permeability is rapid or moderately rapid. If the soils are drained, soil blowing can be a hazard where the soil surface is exposed. Some areas are subject to a slight hazard of frost.

The major management needs on these soils are providing drainage and maintaining organic-matter content and fertility. Tile needs to be installed during the dry season because the substratum is unstable when wet.

These soils are used mainly as woodland. If drained, they are moderately well suited to adapted crops. If these soils are drained, they are well suited to forage. Forage plants that tolerate wetness are needed in undrained areas.

CAPABILITY UNIT IIIwc-6 (4c, 5c)

This unit consists of deep, nearly level, poorly drained soils of the Deford and Wheatley series. These soils have a surface layer of loamy fine sand or mucky loamy sand and a subsoil of loamy fine sand or sand. They are underlain by loamy fine sand or sand and gravel.

Available water capacity is very low to low. Fertility is low. Permeability is rapid. The soils are subject to a hazard of frost. If overdrained, they are subject to soil blowing.

These soils are slow to warm up. Water stands on the surface for long periods. The major management needs are providing drainage and maintaining organic-matter content and fertility. Not all areas of these soils have adequate drainage outlets. They are difficult to drain, because of the nature of the soil and because of the seasonal high water table. The soils are droughty if overdrained.

These soils are mainly used as woodland. They are poorly suited to most adapted crops unless tile drainage is installed. Even if drained, they are limited as to the kind of plants that can be grown.

CAPABILITY UNIT IIIwc-9 (4/2b)

Iosco sand, 0 to 6 percent slopes, is the only soil in this unit. This deep, somewhat poorly drained soil has a surface layer of sand. The subsoil is mainly sand, but the lower part of the subsoil is light clay loam. It is underlain by loam.

Available water capacity is low in the sand layers and high in the lower layers. Fertility is low. Permeability is rapid in the upper layers and moderately slow in the lower layers. Runoff is slow. Soil blowing is a hazard in unprotected areas.

The major management needs are providing drainage and improving and maintaining fertility and organic-matter content. Tile can be used to provide drainage. The soil tends to be slightly droughty.

This soil is used mainly as woodland. If drained, this soil is moderately well suited to crops. It is suited to pasture whether it is drained or undrained.

CAPABILITY UNIT IIIwc-10 (4/2c)

Brevort mucky loamy sand is the only soil in this unit. This deep, nearly level, poorly drained soil has a surface layer of mucky loamy sand. It is underlain by loamy sand and loam.

Available water capacity is low in the sand layers and moderate in the loam layer. Fertility is low. Permeability is rapid in the upper part of the sandy layers and moderately slow in the lower part of the loamy layers. There is a hazard of frost. Soil blowing is a hazard if this soil is drained and left unprotected.

The major management needs are providing drainage and maintaining fertility and organic-matter content. Tile can be used to provide adequate drainage. Some areas lack suitable drainage outlets.

This soil is used as woodland. It is not generally suited to row crops. Drained areas can be used for small grain, hay, and pasture.

CAPABILITY UNIT IIIs-2 (2/Ra, 3/Ra)

This unit consists of moderately deep, nearly level, well drained or moderately well drained soils of the Fairport and Longrie series. These soils have a surface layer of sandy loam or silt loam and a subsoil of sandy loam to silty clay loam. Bedrock is at a depth of 20 to 40 inches.

Available water capacity is moderate to high. Fertility is medium to high. Permeability is moderate to moderately slow. Runoff is slow, and the hazard of erosion is slight.

The Fairport soils are sticky when wet. Practices to maintain good tilth are needed. Some of the moderately well drained areas of these soils remain wet for longer periods after rains than adjoining soils. Random tiling of these areas generally is not practical, because of the depth to bedrock. These areas are small and do not appreciably delay planting. The major management need is maintenance of tilth and fertility. Some of the shallower areas of these soils are slightly droughty.

These soils are used for most adapted crops, for pasture, and as woodland. They are well suited to these uses.

CAPABILITY UNIT IIIs-4 (4a, 4a-a, 4/2a)

This unit consists of deep, nearly level or gently sloping, well drained or moderately well drained soils of the Blue Lake, East Lake, acid variant, Gilchrist, Karlin, Keweenaw, Kiva, Mancelona, Menominee, Rousseau, and Yalmer series. These soils have a surface layer of sand to sandy loam and a subsoil of sand to light gravelly clay loam. East Lake, acid variant, Kiva, and Mancelona soils are underlain by sand and gravel, and Gilchrist, Menominee, and Yalmer soils are underlain by loam or sandy loam. The other soils are underlain by sand to loamy sand.

Most of the soils in this unit have low available water capacity, low fertility, and moderately rapid to rapid permeability. The Karlin and Kiva soils have moderate available water capacity in their loamy layers and very low available water capacity in the underlying material. Menominee soils have moderately slow permeability in the underlying material, and Yalmer soils have slow to moderately slow permeability in the fragipan. Runoff is slow, and the hazard of soil blowing is moderate to severe.

The major management needs are maintenance of organic-matter content and fertility and control of soil blowing. Most of these soils are used as woodland. Small areas are used for crops or pasture. These soils are moderately well suited to adapted crops. Irrigation is needed for high-value crops. Forage crops generally are injured by drought late in summer.

These soils are moderately well suited to crops and pasture.

CAPABILITY UNIT IVe-4 (2.5a, 3a, 3a-a)

This unit consists of deep, sloping to moderately steep, well-drained soils of the Bohemian, Munising, Onaway, Steuben, and Trenary series. These soils have a surface layer of sandy loam or fine sandy loam and a subsoil of loamy sand to clay loam. The underlying material ranges from sand to silt loam.

Available water capacity is moderate to high. Fertility is medium to high. Permeability generally is moderate to moderately slow, but it is slow to moderately slow in the fragipan of the Munising and Steuben soils. Runoff is slow to rapid, depending on the amount and kind of plant cover, and the hazard of erosion is moderate to severe.

The major management need is control of erosion. Contour cropping systems are needed on these soils to control erosion. Waterways need to be grassed to prevent gullying.

These soils are used as woodland and for crops and pasture. The sloping areas are suited to row crops if a conservation cropping system is used. The moderately steep areas are generally too steep for crops. These soils are well suited to pasture.

CAPABILITY UNIT IVe-9 (4a, 4a-a, 4/2a)

This unit consists of deep, sloping to moderately steep, well-drained soils of the Blue Lake, East Lake, acid variant, Karlin, Keweenaw, Kiva, Mancelona, Menominee, Rousseau, and Yalmer series. These soils have a surface layer of sand to sandy loam and a subsoil of sand to light gravelly clay loam. East Lake, acid variant, Kiva, and Mancelona soils are underlain by sand and gravel, and Menominee and Yalmer soils are underlain by loam or sandy loam. The other soils are underlain by sand to loamy sand.

Most of the soils in this unit have low available water capacity, low fertility, and moderately rapid to rapid permeability. Karlin and Kiva soils have moderate available water capacity in their loamy layers and very low available water capacity in the underlying material. Menominee soils have moderately slow permeability in the underlying material, and Yalmer soils have slow to moderately slow permeability in the fragipan. Runoff is slow to rapid, and the hazards of erosion and soil blowing are moderate to severe.

Most areas of these soils are used as woodland. Only small areas are used for crops or pasture. These soils are moderately well suited to poorly suited to crops. Moisture generally is lacking late in summer for most crops. These soils are too steep for irrigation.

The sloping areas are moderately well suited to forage crops. Forage crops generally are injured by drought late in summer. The moderately steep areas are poorly suited to crops and pasture.

CAPABILITY UNIT IVwc-1 (4/Rbc)

Sundell loamy fine sand, sandy variant, 0 to 4 percent slopes, is the only soil in this unit. This moderately deep, somewhat poorly drained soil has a surface layer and subsoil of loamy fine sand. It is underlain by bedrock at a depth of 20 to 40 inches.

Available water capacity is moderate. Fertility is low. Permeability is rapid. Downward movement of water is restricted by bedrock. Runoff is slow. The hazard of erosion is slight.

The major management needs are providing drainage and improving and maintaining fertility and organic-matter content. Depth to bedrock limits the use of tile. Ditches provide adequate drainage for growing forage crops.

This soil is used as woodland and for hay or pasture. It is poorly suited to most row crops. This soil is moderately well suited to small grain and forage crops. Forage crops that tolerate wetness need to be included in seeding mixtures.

CAPABILITY UNIT IVwc-2 (5b)

Au Gres sand, 0 to 6 percent slopes, is the only soil in this unit. This somewhat poorly drained soil has a surface layer and subsoil of sand. It is underlain by sand.

Available water capacity is very low. Fertility is low. Permeability is rapid. Runoff is slow, and the hazard of soil blowing in cleared areas is moderate to severe.

The major management needs are providing drainage, improving and maintaining fertility and organic-matter content, and controlling soil blowing. Tile drains need to be installed during dry seasons because this soil is unstable when wet. Some areas do not have suitable tile outlets.

This soil is mainly used as woodland. The soil generally is too droughty if drained, too low in fertility, and too susceptible to frost to be used for row crops. It is moderately well suited to hay and pasture.

CAPABILITY UNIT IVs-1 (4/Ra, Rbc)

This unit consists of moderately deep, nearly level to moderately steep, well drained or moderately well drained soils of the Deerton and Duel series. These soils have a surface layer of sand or loamy sand and a subsoil of sand or loamy sand. They are underlain by bedrock at a depth of 20 to 40 inches. Also included in this unit are Burt soils in the Deerton-Burt complex. The Burt soils are poorly drained and have a mucky sandy loam surface layer overlying sand. They are underlain by bedrock at a depth of 10 to 20 inches.

All the soils in this unit have low available water capacity and low fertility. Permeability is rapid. Runoff is very slow to medium. The hazard of erosion is slight to moderate, and the hazard of soil blowing is severe.

Almost all areas of these soils are used as woodland. The soils are generally too droughty for most row crops. They are moderately well suited to hay and pasture if drought-resistant grasses are grown.

CAPABILITY UNIT IVs-4 (5a, 5/2a)

This unit consists of deep, nearly level or gently sloping, well drained or moderately well drained soils of the Croswell, East Lake, Kalkaska, and Melita series. These soils generally have a surface layer and subsoil of sand. The lower part of the subsoil is loam in the Melita soils. Croswell and Kalkaska soils are underlain by sand. East Lake soils are underlain by sand and gravel, and Melita soils are underlain by loam.

Available water capacity generally is very low or low, but it is high in the lower, loamy part of the Melita soils. Fertility is low. Permeability is rapid, except in the underlying material of Melita soils, where it is moderately slow. These soils are droughty. Runoff is very slow or slow, and the hazard of soil blowing is severe.

Almost all areas of these soils are used as woodland. Small areas are used for pasture or hay. These soils are poorly suited to crops unless they are irrigated. They are moderately well suited to forage and pasture if drought-resistant grasses are grown.

CAPABILITY UNIT VIe-3 (3/Ra, 4/Ra, Ra)

This unit consists of shallow to moderately deep, sloping to moderately steep, well drained or moderately well drained soils of the Deerton, Longrie, Onota, and Summer-

ville series. These soils generally have a surface layer of sandy loam or fine sandy loam and a subsoil of loamy sand to loam, but Deerton soils have a surface layer of sand and a subsoil of sand or loamy sand. Bedrock generally is at a depth of 20 to 40 inches, but in Summerville soils bedrock is at a depth of 10 to 20 inches.

Available water capacity generally is moderate. Fertility is medium. Permeability is moderate in the Longrie, Onota, and Summerville soils. Available water capacity is low, fertility is low, and permeability is rapid in Deerton soils. Runoff is slow to rapid. The hazard of erosion is severe. These soils are somewhat droughty.

Most areas of these soils are used as woodland. Some of the sloping Longrie and Summerville soils are used as pasture. The soils of this unit are not suited to row crops. The sloping areas are moderately well suited to hay and pasture.

CAPABILITY UNIT VIs-1 (5a)

Kalkaska sand, 6 to 18 percent slopes, is the only soil in this unit. This deep, well-drained soil has a surface layer and subsoil of sand. It is underlain by sand.

Available water capacity is very low. Fertility is low. Permeability is rapid. Runoff is slow. The hazards of erosion and soil blowing are severe.

This soil is too droughty and sloping for crops. The sloping areas are moderately well suited to early pasture. Forage dries up in summer. Most areas are woodland, to which this soil is well suited.

CAPABILITY UNIT VIs-2 (Ga)

Alpena gravelly sandy loam, 0 to 12 percent slopes, is the only soil in this unit. This deep, well-drained soil has a surface layer and subsoil of gravelly sandy loam.

Available water capacity is very low. Fertility is low. Permeability is rapid. Runoff is slow. The hazard of erosion is slight.

This soil is used as woodland. It is too droughty and too shallow to gravel for cultivated crops or pasture.

CAPABILITY UNIT VIs-3 (Ra)

Summerville fine sandy loam, 0 to 4 percent slopes, is the only soil in this unit. This well drained or moderately well drained, shallow soil has a surface layer and subsoil of fine sandy loam. It is underlain by bedrock at a depth of 10 to 20 inches.

Available water capacity is moderate. Fertility is medium. Permeability is moderate. Runoff is slow, and the hazard of erosion is slight. The soil is somewhat droughty.

This soil is used as woodland and for pasture. The shallow, stony areas are not suited to cultivated crops. Where depth to bedrock approaches 20 inches, this soil is moderately well suited to hay and pasture.

CAPABILITY UNIT VIIe-2 (3a-a, 4a)

This unit consists of deep, steep or very steep, well-drained soils of the Blue Lake and Munising series. These soils have a surface layer of sand or sandy loam and a subsoil of sand, loamy sand, and sandy loam. They are underlain by sand or sandy loam.

Available water capacity is low in Blue Lake soils and moderate in Munising soils. Fertility is low in Blue Lake soils and medium in Munising soils. Permeability is rapid in Blue Lake soils, and in Munising soils it is slow to moderately slow in the fragipan and moderate in the rest of the profile. Runoff is slow to medium, and the hazard of erosion is severe.

These soils are used as woodland. They are not suited to crops or to pasture because of steepness.

CAPABILITY UNIT VIIe-3 (3/Ra, M/Rc)

This unit consists only of Onota-Chippeny complex, steep. The moderately deep, moderately steep to very steep, well drained or moderately well drained Onota soils have a surface layer of sandy loam and a subsoil of dominantly sandy loam. Available water capacity is moderate, fertility is medium, and permeability is moderate.

The shallow to moderately deep, moderately steep, very poorly drained Chippeny soils have a surface layer and lower layers of muck. Available water capacity is very high, fertility is low, and permeability is rapid.

The soils in this unit have bedrock at a depth of less than 40 inches, which impedes downward movement of water. Runoff is very slow to rapid. The hazard of erosion is slight to severe.

These soils are used as woodland. They are too steep and are in too complex a pattern to be used for crops or pasture.

CAPABILITY UNIT VIIwc-1 (L-4c)

Only Alluvial land is in this unit. It consists of deep, nearly level, somewhat poorly drained or poorly drained alluvial soils. They have a surface layer and subsoil that range from sand to loam.

Available water capacity is low to moderate, and fertility is low or medium. Permeability ranges from rapid to moderate. Runoff is very slow or ponded. The hazard of erosion is slight.

This land type is used as woodland. It is subject to flooding in spring and after heavy rains. Frost is a hazard in some areas. A few larger areas are used for pasture and hay. This land type is generally poorly suited to crops. If ditch drainage is provided, some of the somewhat poorly drained, larger areas are moderately well suited to hay and pasture.

CAPABILITY UNIT VIIwc-2 (Rbc)

This unit consists of shallow, nearly level to sloping, somewhat poorly drained and poorly drained soils of the Burt, Ensign, and Ruse series. These soils have a surface layer of mucky sandy loam, fine sandy loam, or silt loam and a subsoil of sand, loam, or sandy loam. They are underlain by bedrock at a depth of 10 to 20 inches.

Available water capacity is low to moderate. Fertility is low to medium. Permeability is rapid to moderate, because bedrock impedes downward movement of water. Runoff is slow to ponded. The hazard of erosion is slight.

These soils are used mainly as woodland. They are generally too wet, too shallow, or too subject to frost for cultivated crops. If ditch drainage is provided, they can be used for pasture. The Ensign soils have fewer limitations to use for pasture than Burt or Ruse soils.

CAPABILITY UNIT VIIwc-3 (5a, 5b-h, 5c)

This unit consists of deep, nearly level or gently sloping, somewhat poorly drained or poorly drained soils of the Kinross, Roscommon, and Saugatuck series. Also in this unit are the well drained or moderately well drained

Kalkaska part of Roscommon-Kalkaska sands, 0 to 6 percent slopes. These soils have a surface layer of sand or mucky sand and a subsoil of sand. They are underlain by sand.

Available water capacity is very low. Fertility is low. Permeability generally is rapid or very rapid, but it is slow in the cemented layer in the subsoil of the Saugatuck soils. Runoff is slow to ponded. The hazard of erosion is slight. Frost is a hazard in many areas.

These soils are used as woodland. They generally are too wet, too infertile, and too susceptible to frost action for crops. Under good management, the soils are moderately well suited to pasture.

CAPABILITY UNIT VIIwc-5 (M/4c)

Tawas muck is the only soil in this unit. It is a shallow to moderately deep, nearly level or depressional, very poorly drained soil. The surface layer and the next two layers are muck. They are underlain by sand.

Available water capacity is very high in the organic layers and very low in the underlying sand. Fertility is low. Permeability is rapid in the organic layers and rapid in the underlying material. Runoff is very slow or ponded. The hazard of erosion is slight. The hazard of frost is substantial.

This soil is used as woodland. It is poorly suited to cultivated crops because of wetness, a lack of good drainage outlets, and the hazard of frost. If ditch drainage is provided, a few areas are suitable for pasture if water-tolerant grasses are grown. Grazing needs to be restricted during wet periods.

CAPABILITY UNIT VIIwc-10 (M/3c, M/Rc)

This unit consists of shallow to moderately deep, nearly level or gently sloping, very poorly drained soils of the Cathro, Chippeny, and Tacoosh series. These soils have a surface layer and subsurface layers of muck. Cathro and Tacoosh soils are underlain by loam at a depth of 16 to 51 inches, and Chippeny soils are underlain by bedrock at a depth of 20 to 51 inches.

Available water capacity is very high in the organic layers and moderate in the loamy underlying material. Fertility is low. Permeability is rapid in the organic layers and moderate or moderately slow in the loamy layers. Runoff is very slow or ponded. The hazard of erosion is slight. The hazard of frost is severe.

These soils are used as woodland. They are poorly suited to crops because of wetness, a lack of good drainage outlets, and the hazard of frost. If ditch drainage is provided, a few areas are suitable for pasture if water-tolerant grasses are grown. Grazing needs to be restricted during wet periods.

CAPABILITY UNIT VIIwc-15 (Mc)

This unit consists of deep, nearly level, very poorly drained soils of the Carbondale, Lupton, and Rifle series. These soils have a surface layer of muck or peat and a subsoil of muck or mucky peat.

Available water capacity is very high. Fertility is low. Permeability is rapid. Runoff is very slow or ponded. The hazard of erosion is slight. The hazard of frost is severe.

These soils are used as woodland. They generally are poorly suited to crops because of wetness, the hazard of frost, and a lack of drainage outlets.

CAPABILITY UNIT VIIs-1 (4a, 5a, 5a-h, 5.3a, 5.7a, 5c)

This unit consists of deep, nearly level to very steep, moderately well drained or well drained soils of the Eastport, Grayling, Kalkaska, Rousseau, Rubicon, Shelldrake, and Wallace series. Also in this unit are the poorly drained Roscommon part of Eastport-Roscommon sands, 0 to 6 percent slopes. These soils have a surface layer and subsoil of sand or fine sand.

Available water capacity is low or very low. Fertility is low. Permeability generally is rapid or very rapid, but it is moderately slow in the cemented layer in the subsoil of the Wallace series. Runoff generally is medium to very slow, but it is very slow or ponded on Roscommon soils. The hazard of soil blowing is severe.

These soils are used as woodland. They are too steep, too droughty, or too low in fertility for cultivated crops or pasture.

CAPABILITY UNIT VIIIwc-1 (Mc-a)

This unit consists of shallow to deep, nearly level or depressional, very poorly drained soils of the Dawson and Greenwood series. These soils have a surface layer of peat overlying muck, mucky peat, or peat. The Dawson soils are underlain by sand at a depth of 16 to 51 inches.

Available water capacity is very high in the organic material and very low in the underlying sand of the Dawson soils. Fertility is low. Permeability is rapid in the organic material and rapid in the underlying sand. Runoff is slow or ponded. There is a hazard of frost.

These soils are used for recreation and wildlife. They are poorly suited to cultivated crops, woodland, or pasture because of wetness, acidity, and the hazard of frost.

CAPABILITY UNIT VIIIwc-2

Only Marsh is in this unit. It consists of nearly level lake borders along inland lakes and along Lake Michigan.

Texture, available water capacity, fertility, and permeability are variable. Runoff is slow or very slow.

Marsh is unsuited to crops, pasture, or woodland. It is seepy or is under water much of the year.

CAPABILITY UNIT VIIIs-1

Only Lake beaches is in this unit. It consists of a narrow, nearly level to gently sloping sand beach and a few associated dunes bordering Lake Superior.

The sand has very low available water capacity, very low fertility, and very rapid permeability. Runoff is very slow. The hazard of erosion is slight. The hazard of soil blowing is very severe.

Lake beaches are used for recreation. They are not suited to crops, pasture, or woodland. The beach areas are washed by waves. The dune areas are constantly being shifted by wind. Beach-grass plantings stabilize the dunes to help to reduce soil blowing.

CAPABILITY UNIT VIIIs-2

Only Limestone rock land is in this unit. It is very shallow and nearly level or gently sloping and consists of less than 10 inches of loam or fine sandy loam overlying limestone bedrock.

Available water capacity is very low. Fertility is medium. Permeability is moderate in the soil material. Water moves through the fissures in the bedrock in most areas. Runoff is slow or very slow. The hazard of erosion is slight.

Most areas of this land type are used as woodland. Limestone rock land is poorly suited to cultivated crops. A few areas have been cleared and are used for cattle grazing. Grazing is limited to spring because of droughty conditions during summer. Most areas are very stony.

CAPABILITY UNIT VIIIs-3

This unit consists of Made land and Borrow pits. Depth, slope, texture, available water capacity, fertility, and permeability are all variable.

These land types are not generally suitable for cultivated crops. Borrow pits are areas where soil material has been removed for fill or for sand and gravel. Most of these areas are suitable for planting grasses or trees. Made land consists of areas that have been altered by digging, filling, and grading. Most of these areas are within city limits and are not available for crops.

Predicted Yields

Predicted average yields per acre of principal crops grown in the Area are given in table 2. The predicted yields are for crops grown under an improved level of management.

The soils of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties vary considerably in their ability to produce crops. Some consistently produce higher yields, while others are better suited to less intensive uses because of soil limitations or hazard of erosion.

The farming areas in the survey area are generally limited to the southern and western parts of Delta County and the area around Chatham and Cooks. These are areas that have soils most suitable for crop production. Another major factor determining use of the soils for farming is land ownership. About 60 percent of the land in the survey area is administered by State and Federal agencies and is owned by large commercial interests. Most of this land is sandy or wet and is mainly in the eastern and central parts of the survey area.

Climate limits the kinds of crops that can be grown in the survey area. Except in areas close to Lake Michigan, corn for grain will not mature most years because of frost. Many of the wet soils are subject to frost late in spring and early in fall. Adequate tile outlets are not available in many areas.

The yield predictions for soils in capability classes II, III, and IV are given in table 2. No class I soils are in the survey area, because of climatic limitations. These predictions are average acre yields that can be expected under improved management. Improved management includes most of the following practices:

1. The cropping system is adapted to the soil, using the proper proportion of row crops to legume-grass crops.
2. The conservation measures needed to control erosion and soil blowing are used. Suitable measures include contour tillage, stripcropping, minimum tillage, and return of crop residue to the soil.
3. Crop residue, cover crops, and manure are returned to the soil to improve soil structure, supply organic matter, and help to control erosion.
4. The quantity of lime applied is determined by soil tests. Applications of fertilizer are based on the amount and kinds of plant food needed by the crop to be grown.
5. An adequate system of artificial drainage is installed where needed.
6. Improved varieties of plants and high-quality seeds are used.
7. Weed, disease, and insect control is practiced.
8. Suitable methods and proper timing of tillage and harvesting are used.

The crop yields given in table 2 are those that are expected over a period of several years and that can be expected when moisture and length of growing season are adequate. The yields given are not presumed to be the optimum yields obtainable. Potential yields per acre are somewhat higher, especially with a favorable combination of soil, plant, and weather conditions. Irrigation is not considered a part of the improved level of management unless stated for the individual soils and crops. No predictions are given if the soil is not suited to the crop or if the crop generally is not grown on the soil.

In many places, soils are not used for crops. In these instances, the predicted yields give an indication of the relative potential productivity of these soils for crops.

Woodland

Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties were originally covered by forest, dominantly hardwoods (fig. 18). The main species were sugar maple, yellow birch, beech, and scattered white pine and hemlock. The stands of hardwood-conifer consisted of hardwoods mixed with white pine, balsam fir, hemlock, and spruce. Red pine and jack pine grew on the dry sands. Red pine and white pine grew on the moist, more fertile sands. Conifers and such swamp hardwoods as ash, elm, balm-of-Gilead, red maple, white birch, and aspen grew on the wetter mineral soils. Conifer swamp forest consisting mainly of white cedar, black spruce, and tamarack grew on the organic soils.

Cutting of the original forest began in the 1880's and continued until the 1920's. Most of the woodland is now recovering from the clear cutting and the fires that followed the cutting.

Logging is still a large segment of the forest industry in the survey area, but wood for pulp, rather than saw logs, is the major wood crop. Other woodland products are fenceposts, cedar for summer homes, Christmas trees, boughs for wreaths, and hardwood for veneer.

About 90 percent of the survey area is wooded (fig. 19). More than half of the wooded acreage is National Forest Land or is owned by the State of Michigan and several large paper and iron companies. The remaining acreage is in relatively small privately owned parcels. Much of

TABLE 2.—*Predicted average yields per acre of crops grown under an improved level of management*

[Yields are given only for soils that are currently farmed or that have a high potential for farming. Dashes indicate that a soil is not suited to the crop or that the crop is not generally grown on it]

Soil	Corn (silage)	Oats	Alfalfa-brome hay	Mixed hay	Potatoes	Field beans
	Tons	*Bu*	*Tons*	*Tons*	*Bu*	*Bu*
Au Gres sand, 0 to 6 percent slopes	10	45		2.0		
Au Gres loamy sand, gravelly subsoil variant, 0 to 4 percent slopes	12	50	2.8	2.2		
Blue Lake sand, 0 to 6 percent slopes	12	60	3.0	2.2	[1] 450	
Bohemian fine sandy loam, 0 to 6 percent slopes	15	80	3.5	2.5	600	
Bohemian fine sandy loam, 6 to 18 percent slopes	13	65	3.2	2.0	400	
Bowers silt loam, 0 to 4 percent slopes	15	75	3.5	2.8		
Brevort mucky loamy sand, 0 to 2 percent slopes		70		2.3		
Brimley fine sandy loam, 0 to 4 percent slopes	15	80	3.4	2.4	650	
Bruce mucky fine sandy loam, coarse variant, 0 to 2 percent slopes		75		2.0		
Charlevoix sandy loam, 0 to 4 percent slopes	15	80	3.5		650	
Chatham fine sandy loam, 0 to 2 percent slopes	14	75	3.4	2.5	575	
Chatham fine sandy loam, 2 to 6 percent slopes	14	75	3.4	2.5	575	
Chatham fine sandy loam, 6 to 18 percent slopes		65	3.2	2.0		
Croswell sand, 0 to 4 percent slopes	10	45	2.5	1.8		
Deford loamy fine sand, 0 to 2 percent slopes	12		2.7	2.1		
Duel loamy sand, 0 to 6 percent slopes	10	45	2.2	1.5	[1] 375	
East Lake sand, 0 to 6 percent slopes	11	45	2.0	1.5	[1] 375	
Emmet sandy loam, 0 to 2 percent slopes	15	80	3.4	2.4	650	
Emmet sandy loam, 2 to 6 percent slopes	15	80	3.5	2.5	600	
Emmet sandy loam, 6 to 12 percent slopes	14	65	3.2	2.0	500	
Ensley and Angelica soils, 0 to 2 percent slopes		75	3.4	2.4		
Fairport silt loam, 0 to 2 percent slopes	16	85	3.5	2.5		55
Fairport silt loam, 2 to 6 percent slopes	16	85	3.5	2.5		55
Gilchrist sand, 0 to 6 percent slopes	12	60	2.8	2.0	[1] 450	
Iosco sand, 0 to 6 percent slopes	11	45	2.6	1.9		
Kalkaska sand, 0 to 6 percent slopes	10	45	2.0	1.5	[1] 375	
Karlin sandy loam, 0 to 6 percent slopes	12	65	3.2	2.0	[1] 500	40
Karlin sandy loam, 6 to 18 percent slopes	8	40	2.5	1.8		
Kawbawgam sandy loam, 0 to 10 percent slopes		60		2.5		
Kawkawlin silt loam, 0 to 2 percent slopes	18	85	3.8	2.8		
Keweenaw loamy sand, 0 to 6 percent slopes	12	60	2.5	2.0	[1] 500	
Kiva sandy loam, 0 to 6 percent slopes	12	60	2.8	2.0	[1] 450	
Kiva sandy loam, 6 to 20 percent slopes	8	45	2.6	1.8		
Longrie sandy loam, 0 to 2 percent slopes	16	80	3.4	2.4	550	50
Longrie sandy loam, 2 to 6 percent slopes	16	80	3.4	2.4	550	50
Mancelona loamy sand, 0 to 6 percent slopes	12	55	3.0	2.0	[1] 425	
Melita sand, 0 to 6 percent slopes	10	45	2.0	1.5	[1] 400	
Menominee loamy sand, 0 to 6 percent slopes	12	55	3.0	2.0	[1] 425	
Menominee loamy sand, 6 to 18 percent slopes	8	40	2.5	1.8		
Munising sandy loam, 0 to 6 percent slopes	15	75	3.0	2.5	580	
Munising sandy loam, 6 to 18 percent slopes	14	65	2.8	2.0	500	
Nahma loam, 0 to 2 percent slopes		75		2.6		
Nester silt loam, 0 to 2 percent slopes	18	85	3.8	2.8		55
Nester silt loam, 2 to 6 percent slopes	18	85	3.8	2.8		55
Onaway fine sandy loam, 0 to 2 percent slopes	17	85	3.5	2.5	700	55
Onaway fine sandy loam, 2 to 6 percent slopes	17	85	3.5	2.5	700	55
Onaway fine sandy loam, 6 to 12 percent slopes	15	80	3.5	2.3	500	
Onaway fine sandy loam, 12 to 18 percent slopes		65	3.0	2.0		
Otisco loamy sand, 0 to 6 percent slopes	14	60	2.8	2.0	425	
Pickford silt loam, 0 to 2 percent slopes	14	70		2.4		
Pickford silt loam, moderately wet, 0 to 4 percent slopes	14	75	3.2	2.4		
Pickford complex, 0 to 4 percent slopes	14	70		2.4		
Rousseau fine sand, 0 to 6 percent slopes	12	60	2.8	2.0	[1] 425	
Rousseau fine sand, 6 to 18 percent slopes	10	45	2.5	1.8		
Skanee sandy loam, 0 to 6 percent slopes	15	75	3.0	2.4	580	
Steuben fine sandy loam, 0 to 6 percent slopes	14	70	3.0	2.5	550	
Sundell fine sandy loam, 0 to 4 percent slopes	16	80		2.4		
Sundell loamy fine sand, sandy variant, 0 to 4 percent slopes	10	45		1.5		
Trenary fine sandy loam, 0 to 2 percent slopes	18	85	3.5	2.8	700	
Trenary fine sandy loam, 2 to 6 percent slopes	17	85	3.5	2.5	700	
Trenary fine sandy loam, 6 to 12 percent slopes	15	80	3.2	2.3	500	
Trenary fine sandy loam, 12 to 18 percent slopes		65	3.0	2.0		
Wainola fine sand, 0 to 4 percent slopes	12	60		2.0	425	
Wheatley mucky loamy sand, 0 to 2 percent slopes		65	2.7	2.1		

[1] With irrigation.

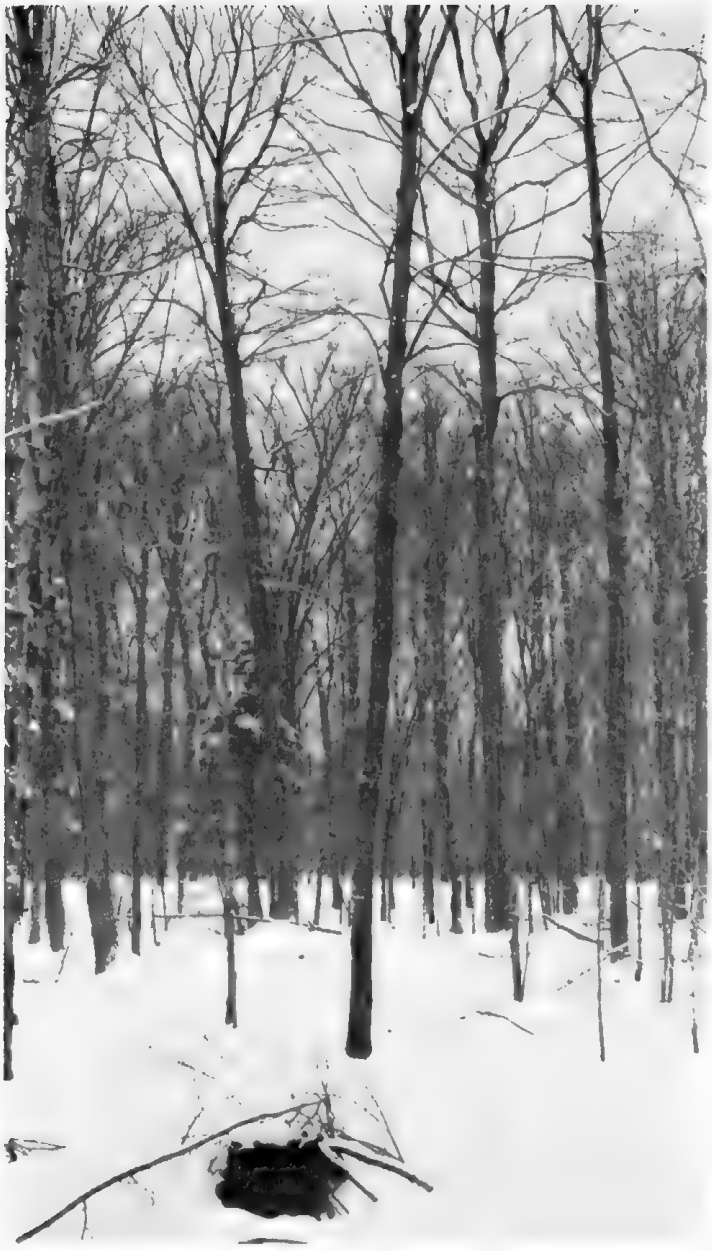

Figure 18.—A stand of hardwood trees in an area of Trenary fine sandy loam. Woodland suitability group 2d1.

the private acreage is used as private hunting and camping areas.

Woodland suitability groups

In table 3 the soils in this survey area have been placed in 19 woodland suitability groups to assist owners in planning the use of their soils for wood crops. Inasmuch as the woodland suitability groups are established on a statewide basis, not all groups are represented in the survey area. Alluvial land, Borrow pits, Limestone rock land, Made land and the extremely acid organic soils of the Dawson and Greenwood series are not placed in a woodland suitability group. Woodland management of these areas requires specific recommendations from local soil conservationists or forestry technicians.

Each woodland suitability group consists of the kinds of soil that are capable of producing similar kinds of wood crops, that need similar management to produce these crops when existing vegetation is similar, and that have about the same potential productivity. For each woodland suitability group, table 3 provides information concerning potential soil productivity, which is expressed as site index; soil-related hazards and major limitations to be considered in management; species to favor in management of existing stands; and trees preferred for planting. These factors are explained in the paragraphs that follow.

Potential soil productivity for a given species is commonly expressed as site index. It is the height in feet that the dominant trees of a given species, growing on a specified soil, will reach in a natural, unmanaged stand in a stated number of years. On the basis of the site index, rates of growth can be calculated. The rates are expressed as approximate average annual growth per acre in board feet (International ¼-inch rule) in table 3. The soils were ordinated to the first species listed in the "species" column.

Erosion hazard refers to the potential hazard of soil losses by wind or water in well-managed woodland. Soil properties considered in the ratings are surface texture and slope. The hazard is *slight* if expected soil losses are small; *moderate* if some soil losses are expected and care is needed during logging and construction to reduce the risk of erosion; and *severe* if special methods of operation are necessary for preventing excessive soil losses.

Equipment limitations are rated on the basis of soil characteristics that restrict or prohibit the use of equipment commonly used in tending and harvesting the trees. In the survey area, soil characteristics having the most limiting effect are drainage, depth to water table, seasonal wetness, and texture of the surface layer. *Slight* means there is no restriction in the kind of equipment or in the time of year it is used; *moderate* means that use of equipment is restricted for less than 3 months of the year; and *severe* means that special equipment is needed, and its use is restricted for more than 3 months of the year.

Seedling mortality refers to the expected degree of mortality of naturally occurring or planted seedlings as influenced by kinds of soil when plant competition is not a limiting factor. Soil properties considered in the ratings are drainage, effective rooting depth, and surface texture. Normal rainfall, good planting stock, and proper planting are assumed. A rating of *slight* indicates an expected loss of less than 25 percent of the seedlings; *moderate*, a loss of 25 to 50 percent of the seedlings; and *severe*, a loss of more than 50 percent of the seedlings. Browsing by deer and rabbits results in seedling loss, but severity of loss varies within the survey area and is not considered in the mortality rating.

Plant competition refers to invasion by, or growth of, undesirable species when openings are made in the tree canopy. Soil properties considered in the ratings are available water capacity, natural fertility, and drainage. A rating of *slight* means that competition from other plants is not a problem; *moderate*, that plant competition generally does not prevent development of fully stocked

Figure 19. **A stand of hardwood trees in an area of Munising sandy loam. Woodland suitability group 2d1.**

stands of desirable trees; and *severe*, that plant competition prevents establishment of a desirable stand unless intensive site preparation and maintenance are used to control undesirable plants.

Windthrow hazard, or the danger of trees being blown over by wind, is an evaluation of soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. The hazard is *slight* if most trees are not expected to be blown down during commonly occurring winds; *moderate* if some trees are blown down during periods of excessive soil wetness and strong wind; and *severe* if many trees are blown down during periods of excessive soil wetness and moderate or strong wind. The rating given is for closed stands. Windthrow hazard is more severe where the woodland has been thinned or individual trees are left standing.

Species to favor in natural stands for each woodland suitability group are listed in order of priority, with the first species listed having the highest priority. The species are selected on the basis of their adaptability or tolerance and their productivity and commercial value, They should be given the most consideration when making improvement cuttings.

Species preferred for planting is a listing of the most suitable trees for open-field and woodland interplanting on the soils in each woodland suitability group. When it is desired to plant trees other than those listed, those trees that should be favored in natural stands are the ones most likely to succeed or to be worth growing. Trees are not commonly planted on somewhat poorly drained and poorly drained soils that have not been artificially drained.

Each woodland group is identified by a three-part symbol; for example, 2s3, 3d1, or 4w1. The first part of the symbol, always a number, indicates relative potential productivity of the soils in the group: 1 is very high; 2 is high; 3 is moderately high; 4 is moderate; and 5 is low. These ratings are based on field determinations of average site index. The second part of the symbol identifying a woodland group is a small letter. This letter indicates an important soil property that imposes a moderate or severe hazard or limitation in managing the soils of the group for wood crops. A letter *c* shows that the main limitation is the kind or amount of clay in the upper part of the soils in the group; *d* shows that the soils have a restricted rooting depth; *f* indicates fragmented or skeletal soils; *o* shows that

the soils have few limitations that restrict their use for trees; *s* shows that the soils are sandy and dry, have low available water capacity, and generally have a low supply of plant nutrients; *r* shows that the soils have restrictions because of steepness of slope; and *w* shows that water in or on the soils, either seasonally or year round, is the chief limitation. The last part of the symbol, another common number, identifies the specific woodland suitability group.

Wildlife [3]

Table 4 rates the soils according to their suitability for elements of wildlife habitat and for general kinds of wildlife. A rating of *well suited* means that the soil is relatively free of limitations or that the limitations are easily overcome. *Suited* means that the limitations need to be recognized, but that they can be overcome by good management and careful design. *Poorly suited* means that limitations are severe enough to make use of the soil questionable for wildlife habitat. *Not suited* means that extreme measures are needed to overcome the limitations and that use generally is not practical. The elements of wildlife habitat are discussed briefly in the following paragraphs.

Grain and seed crops.—Among these crops are corn, oats, rye, buckwheat, field beans, and barley.

Grasses and legumes.—These are planted grasses and legumes commonly used for forage. Examples are bromegrass, fescue, timothy, birdsfoot trefoil, reed canarygrass, clovers, and alfalfa.

Wild herbaceous upland plants.—In this group are native annuals or other herbaceous plants that commonly grow in upland areas. Among them are strawberries, dandelion, goldenrod, lambsquarters, orange hawkweed, thimbleberry, mildweed, mullin, burdock, and native grasses.

Hardwood woody plants.—These plants are hardwood trees and shrubs that grow vigorously and produce sprouts, fruits, or seeds that wildlife feed on. These woody plants either grow naturally or are planted. Examples are maple, beech, oak, poplar, birch, dogwood, willow, hawthorn, viburnum, wintergreen, raspberries, blackberries, cherries, and blueberries.

Coniferous woody plants.—Examples of native or planted coniferous trees and shrubs are pine, spruce, white cedar, hemlock, balsam fir, yew, larch, and juniper.

Wetland food and cover plants.—These are plants that grow in moist or wet sites and that provide food and cover for waterfowl and furbearing animals. Examples are cattails, sedges, bulrushes, water smartweed, wild millet, water plantain, wildrice, arrowhead, pondweed, pickerelweed, wild celery, duckweed, and burreed.

Shallow-water developments.—These are impoundments of shallow water in marshy areas and stream channels. They consist of low dikes, nearly level ditches, dugouts, and devices to maintain water at a depth suitable for wetland wildlife.

Excavated ponds.—Migrating waterfowl are especially attracted to excavated ponds, or dugout ponds. Such ponds should have an independent source of water. They should not depend on runoff from surrounding areas, although they benefit from runoff that is not excessive.

[3] By CHARLES M. SMITH, biologist, Soil Conservation Service.

The ratings shown in table 4 under the heading "Kinds of wildlife" apply to wildlife in general and not to a specific species. Not considered, therefore, are present land use, existing vegetation, and the extent of artificial drainage provided, because these factors are subject to change. Neither is consideration given to the ability of wildlife to move from place to place.

A rating of *well suited* or *suited* means that the soil can be managed most practically and with the best chance of success. A rating of *poorly suited* does not necessarily mean that a soil cannot be managed for wildlife, but it does show that a high level of management is required to improve the soil. Following are discussions of the kinds of wildlife.

Open-land wildlife.—This kind of wildlife is made up of birds and mammals that normally frequent cropland, pastureland, meadow, and areas overgrown with grasses, herbs, and shrubs. Examples are field sparrow, red fox, woodchuck, hawks, field mice, robin, cottontail rabbit, and sharp-tailed grouse.

Woodland wildlife.—These birds and mammals frequent wooded areas consisting of hardwood trees, coniferous trees, shrubs, or mixed stands of such plants. Among them are tree squirrels, raccoon, ruffed grouse, woodpeckers, warblers, nuthatch, white-tailed deer, coyote, bobcat, black bear, owl, snowshoe hare, Canada lynx, and timber wolf.

Wetland wildlife.—In this group are birds and mammals that normally frequent such wet areas as ponds, marshes, and swamps. Examples are muskrat, ducks, geese, herons, kingfisher, mink, weasel, beaver, otter, cranes, and bitterns.

Engineering Uses of the Soils [4]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for storing water, structures for controlling erosion, drainage systems, and systems for disposing of sewage. Among the soil properties most important to engineers are permeability, shear strength, compaction characteristics, drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Also important are depth to water table, flooding hazard, depth to bedrock, and relief. Such information is made available in this subsection. Engineers can use it to—

1. Make studies of soil and land use that aid in selecting and developing sites for industries, businesses, residences, and recreational facilities.
2. Make estimates of engineerig properties for use in planning agricultural drainage structures, dams, and other structures for conserving soil and water; in locating suitable routes for underground conduits and cables; and in locating sites for sewage disposal fields.
3. Make preliminary evaluations of soil conditions that will aid in selecting locations for highways, airports, pipelines, and sewage disposal fields and in planning detailed surveys of the soils at the selected locations.

[4] KEITH I. BAKEMAN, civil engineer, Soil Conservation Service, assisted in preparing this section.

TABLE 3.—*Woodland*

[Average annual growth per acre in board feet, International ¼ inch rule. Data are not included for Alluvial land, Borrow pits,

Woodland suitability groups, series, and mapping units	Soil slope range	Potential soil productivity		
		Species	Site index	Approximate average annual growth per acre
	Percent		*Ft.*	*Bd. ft.*
Group 2d1: Soils of the Munising, Steuben, and Trenary series MuB, MuD, StB, StD, TrA, TrB, TrC, TrD.	0 to 18	Sugar maple	58–65	190–260
Group 2d2: Soils of the Munising series MuE.	18 to 40	Sugar maple	58–65	190–260
Group 2f1: Soils of the Alpena and Kiva series AlC, KsB, KsD.	0 to 12	Sugar maple	58–65	190–260
Group 2s1: Soils of the Blue Lake, East Lake, acid, variant, Gilchrist, Karlin, Keweenaw, Melita, Menominee, Mancelona, Rousseau, and Yalmer series. BlB, BlD, EcB, EcD, GcB, KdB, KdD, KnB, KnD, McB, McD, MnB, MnD, RoB, RoD, YaB, YaD.	0 to 20	Sugar maple	58–65	190–260
Group 2s2: Soils of the Blue Lake and Rousseau series BlE, RsD.	18 to 40	Sugar maple	58–65	190–260
Group 2s3: Soils of the Croswell, Eastport, Rubicon, Shelldrake, and Wallace series. CrA, EdB, EeB, RuB, RuD, ShB, WlB, WlD. For the Roscommon part of EeB, see woodland suitability group 5w1.	0 to 18	Red pine	58–65	430–500
Group 2s4: Soils of the Rubicon series RuE.	18 to 40	Red pine	58–65	430–500
Group 2o1: Soils of the Bohemian, Chatham, Emmet, Longrie, Onaway, and Onota series. BoB, BoD, CmA, CmB, CmD, EmA, EmB, EmC, LoA, LoB, LsD, OnA, OnB, OnC, OnD, OrB, OrD. For Summerville part of LsD, see woodland suitability group 3d1; for Deerton part of OrB and OrD, see woodland suitability groups 3s1 and 3s2.	0 to 18	Sugar maple	58–65	190–260
Group 2o3: Soils of the Fairport, Kawkawlin, and Nester series FaA, FaB, KlA, NsA, NsB.	0 to 6	Sugar maple	58–65	190–260
Group 2o5: Soils of the Bowers, Brimley, Charlevoix, Kawbawgam, Skanee, and Sundell series. BrA, BtA, ClA, KgC, SkB, SvA.	0 to 10	Sugar maple	58–65	190–260
Group 2r1: Soils of the Onota series OoE. For Chippeny part of OoE, see woodland suitability group 5w2.	15 to 70	Sugar maple	58–65	190–260
Group 3d1: Soils of the Ensign and Summerville series EnA, SuA.	0 to 4	Sugar maple	50–57	130–190
Group 3s1: Soils of the Deerton, Duel, East Lake, and Kalkaska series DeB, DeD, DlB, DuB, EaB, KaB, KaD. For Burt part of DlB, see woodland suitability group 4w1.	0 to 18	Sugar maple	50–57	130–190
Group 3s2: Soils of the Kalkaska series KaE.	18 to 40	Sugar maple	50–57	130–190
Group 3s3: Soils of the Au Gres, Au Gres, gravelly subsoil variant, Iosco, Otisco, Sundell, sandy variant, and Wainola series. AuB, AvA, IoB, OtB, SwA, WaA.	0 to 6	Quaking aspen	56–65	125–150
Group 4s1: Soils of the Grayling series GrB, GrD.	0 to 18	Jack pine	41–50	100–125

interpretations

Lake beaches, Limestone rock land, Made land, and Marsh, and the extremely acid organic soils of the Dawson and Greenwood series]

Ratings for management hazards or limitations					Species—	
Erosion hazard	Equipment limitations	Seedling mortality	Plant competition	Windthrow hazard	To favor in natural stands	Preferred for planting
Slight	Slight	Slight	Moderate	Slight to moderate.	Sugar maple, yellow birch, white pine.	White spruce, red pine.
Moderate	Moderate	Slight	Moderate	Moderate	Sugar maple, yellow birch, white pine.	White spruce, red pine.
Slight	Slight	Slight	Slight	Slight	Sugar maple, yellow birch, white pine.	White spruce, red pine.
Slight	Slight	Slight to moderate.	Slight	Slight	Sugar maple, yellow birch, white pine.	Red pine.
Moderate	Moderate	Slight to moderate.	Slight	Slight	Sugar maple, yellow birch, white pine.	Red pine.
Slight to moderate.	Slight to moderate.	Moderate	Slight	Slight	Red pine, aspen, black cherry.	Red pine.
Moderate	Moderate	Moderate	Slight	Slight	Red pine, black cherry, aspen.	Red pine.
Slight	Slight	Slight	Moderate	Slight to moderate.	Sugar maple, yellow birch, white pine.	White spruce, red pine.
Slight	Slight to moderate.	Slight	Moderate to severe.	Slight	Sugar maple, yellow birch, white pine.	White spruce, red pine.
Slight	Moderate	Slight	Moderate to severe.	Slight	Sugar maple, yellow birch.	Not generally planted.
Moderate	Moderate	Slight	Moderate	Slight	Sugar maple, yellow birch, white pine.	White spruce, red pine.
Slight	Slight	Severe	Slight	Moderate	Sugar maple, yellow birch, red pine.	Not generally planted.
Slight	Slight	Moderate	Slight	Slight	Sugar maple, yellow birch, red pine.	Red pine.
Moderate	Moderate	Moderate	Slight	Slight	Sugar maple, yellow birch, red pine.	Red pine.
Slight	Moderate	Slight	Moderate	Slight	Aspen, sugar maple, balsam fir.	White spruce, black spruce.
Slight	Slight	Moderate	Slight	Slight	Jack pine, red pine	Jack pine, red pine.

TABLE 3.—*Woodland*

Woodland suitability groups, series, and mapping units	Soil slope range	Potential soil productivity		
		Species	Site index	Approximate average annual growth per acre
	Percent		*Ft.*	*Bd. ft.*
Group 4w1: Soils of the Angelica, Bruce, Burt, Ensley, Nahma, Pickford, Pickford, moderately wet, and Ruse series. Bu, BwC, Es, Nh, Pc, PfA, PkA, Rv.	0 to 12	Balsam fir	41–49	175–225
Group 5w1: Soils of the Brevort, Deford, Kinross, Roscommon, Kalkaska, Saugatuck, and Wheatley series. Bs, Dm, Kr, Rc, RkB, ScA, Wm. For Kalkaska part of RkB, see woodland suitability group 3s1.	0 to 6	Quaking aspen	<45	<100
Group 5w2: Soils of the Carbondale, Cathro, Chippeny, Lupton, Rifle, Tacoosh, and Tawas series. Cb, Ch, Ck, Cn, Ta.	0 to 6	Balsam fir	<40	<175

TABLE 4.—*Suitability of the soils for elements of*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woody plants
Alluvial land: Ad	Suited	Suited	Well suited	Suited
Alpena: AlC	Not suited	Not suited	Not suited	Poorly suited
Angelica Mapped only with Ensley soils.	Not suited	Poorly suited	Poorly suited	Suited
Au Gres: AuB	Not suited	Poorly suited	Poorly suited	Poorly suited
Au Gres, gravelly subsoil variant: AvA	Not suited	Poorly suited	Poorly suited	Poorly suited
Blue Lake: BlB BlD BlE	Suited Poorly suited Not suited	Well suited Suited Poorly suited	Well suited Well suited Well suited	Well suited Well suited Well suited
Bohemian: BoB BoD	Well suited Poorly suited	Well suited Suited	Well suited Well suited	Well suited Well suited
Borrow pits: Bp. Too variable to rate.				
Bowers: BrA	Suited	Suited	Well suited	Suited
Brevort: Bs	Not suited	Poorly suited	Poorly suited	Not suited
Brimley: BtA	Suited	Suited	Well suited	Suited
Bruce, coarse variant: Bu	Not suited	Poorly suited	Poorly suited	Well suited
Burt: BwC	Not suited	Poorly suited	Poorly suited	Suited
Carbondale: Cb For Lupton and Rifle parts, see Lupton and Rifle series.	Not suited	Poorly suited	Not suited	Not suited

interpretations—Continued

Ratings for management hazards or limitations					Species—	
Erosion hazard	Equipment limitations	Seedling mortality	Plant competition	Windthrow hazard	To favor in natural stands	Preferred for planting
Slight	Severe	Severe	Severe	Moderate to severe.	Balsam fir, sugar maple, yellow birch.	Not generally planted.
Slight	Severe	Severe	Severe	Moderate	Aspen, sugar maple, balsam fir.	Not generally planted.
Slight	Severe	Severe	Severe	Severe	Tamarack, white-cedar, black ash.	Not generally planted.

wildlife habitat and for kinds of wildlife

Elements of wildlife habitat Continued				Kinds of wildlife		
Coniferous woody plants	Wetland food and cover plants	Shallow-water developments	Excavated ponds	Open-land	Woodland	Wetland
Suited	Suited	Suited	Suited	Well suited	Suited	Suited.
Poorly suited	Not suited	Not suited	Not suited	Not suited	Not suited	Not suited.
Well suited	Well suited	Well suited	Well suited	Poorly suited	Suited	Well suited.
Well suited	Poorly suited	Suited	Suited	Poorly suited	Poorly suited	Poorly suited.
Well suited	Poorly suited	Suited	Suited	Poorly suited	Poorly suited	Poorly suited.
Suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Suited	Suited	Suited	Suited	Well suited	Suited	Suited.
Well suited	Not suited	Well suited	Well suited	Poorly suited	Well suited	Poorly suited.
Suited	Suited	Suited	Suited	Well suited	Suited	Suited.
Well suited	Well suited	Well suited	Well suited	Poorly suited	Suited	Well suited.
Well suited	Well suited	Suited	Not suited	Poorly suited	Suited	Suited.
Poorly suited	Suited	Well suited	Well suited	Not suited	Not suited	Well suited.

TABLE 4.—*Suitability of the soils for elements of*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woody plants
Cathro: Ch, Ck For Tacoosh part of Ck, see Tacoosh series.	Not suited	Poorly suited	Not suited	Not suited
Charlevoix: ClA	Suited	Suited	Well suited	Suited
Chatham: CmA, CmB	Well suited	Well suited	Well suited	Well suited
CmD	Poorly suited	Suited	Well suited	Well suited
Chippeny: Cn	Not suited	Poorly suited	Not suited	Not suited
Croswell: CrA	Not suited	Poorly suited	Poorly suited	Poorly suited
Dawson: Da, Dd For Greenwood part of Dd, see Greenwood series.	Not suited	Not suited	Not suited	Not suited
Deerton: DeB, DlB For Burt part of DlB, see Burt series.	Suited	Suited	Well suited	Well suited
DeD	Poorly suited	Suited	Well suited	Well suited
Deford: Dm	Not suited	Poorly suited	Poorly suited	Poorly suited
Duel: DuB	Suited	Suited	Well suited	Well suited
East Lake: EaB	Not suited	Poorly suited	Poorly suited	Poorly suited
East Lake, acid variant: EcB, EcD	Not suited	Poorly suited	Poorly suited	Poorly suited
Eastport: EdB, EeB For Roscommon part of EeB, see Roscommon series.	Not suited	Not suited	Poorly suited	Poorly suited
Emmet: EmA	Well suited	Well suited	Well suited	Well suited
EmB, EmC	Suited	Well suited	Well suited	Well suited
Ensign: EnA	Poorly suited	Poorly suited	Suited	Suited
Ensley: Es For Angelica part, see Angelica series.	Not suited	Poorly suited	Poorly suited	Well suited
Fairport: FaA, FaB	Well suited	Well suited	Well suited	Well suited
Gilchrist: GcB	Suited	Suited	Well suited	Suited
Grayling: GrB	Not suited	Not suited	Poorly suited	Poorly suited
GrD	Not suited	Not suited	Poorly suited	Poorly suited
Greenwood: Gw	Not suited	Poorly suited	Not suited	Not suited
Iosco: IoB	Not suited	Poorly suited	Poorly suited	Poorly suited
Kalkaska: KaB, KaD, KaE	Not suited	Poorly suited	Poorly suited	Poorly suited
Karlin: KdB	Suited	Well suited	Suited	Well suited
KdD	Poorly suited	Suited	Suited	Well suited
Kawbawgam: KgC	Suited	Suited	Well suited	Well suited
Kawkawlin: KlA	Suited	Suited	Well suited	Well suited
Keweenaw: KnB	Suited	Well suited	Well suited	Well suited
KnD	Poorly suited	Suited	Well suited	Well suited

wildlife habitat and for kinds of wildlife—Continued

Elements of wildlife habitat—Continued				Kinds of wildlife		
Coniferous woody plants	Wetland food and cover plants	Shallow-water developments	Excavated ponds	Open-land	Woodland	Wetland
Poorly suited	Suited	Well suited	Well suited	Not suited	Not suited	Well suited.
Suited	Suited	Suited	Suited	Well suited	Suited	Suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Well suited	Not suited.
Poorly suited	Suited	Suited	Not suited	Not suited	Poorly suited	Suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Not suited	Not suited	Well suited	Well suited	Not suited	Not suited	Well suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Well suited	Not suited	Well suited	Well suited	Poorly suited	Poorly suited	Poorly suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Suited	Not suited	Not suited	Poorly suited	Suited	Suited.
Well suited	Well suited	Well suited	Well suited	Poorly suited	Suited	Well suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Not suited	Not suited	Well suited	Well suited	Not suited	Not suited	Well suited.
Suited	Poorly suited	Suited	Suited	Poorly suited	Not suited	Poorly suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Suited	Suited	Not suited	Not suited	Well suited	Suited	Suited.
Suited	Suited	Suited	Suited	Well suited	Suited	Suited.
Suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.

TABLE 4.—*Suitability of the soils for elements of*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woody plants
Kinross: Kr	Not suited	Not suited	Not suited	Not suited
Kiva:				
KsB	Suited	Well suited	Suited	Suited
KsD	Poorly suited	Suited	Suited	Suited
Lake beaches: Lb	Not suited	Not suited	Not suited	Not suited
Limestone rock land: Lm	Not suited	Poorly suited	Suited	Suited
Longrie:				
LoA, LoB	Well suited	Well suited	Well suited	Well suited
LsD	Poorly suited	Suited	Well suited	Well suited
For Summerville part, see Summerville series.				
Lupton	Not suited	Poorly suited	Not suited	Not suited
Mapped only with Carbondale and Rifle series.				
Made land: Ma.				
Too variable to rate.				
Mancelona:				
McB	Suited	Well suited	Well suited	Well suited
McD	Poorly suited	Suited	Well suited	Well suited
Marsh: Mh	Not suited	Not suited	Not suited	Not suited
Melita: MlB	Not suited	Poorly suited	Poorly suited	Poorly suited
Menominee:				
MnB	Suited	Suited	Well suited	Suited
MnD	Poorly suited	Suited	Well suited	Suited
Munising:				
MuB	Well suited	Well suited	Well suited	Well suited
MuD	Suited	Suited	Well suited	Well suited
MuE	Not suited	Poorly suited	Well suited	Well suited
Nahma: Nh	Not suited	Poorly suited	Poorly suited	Suited
Nester: NsA, NsB	Well suited	Well suited	Well suited	Well suited
Onaway:				
OnA, OnB	Well suited	Well suited	Well suited	Well suited
OnC	Suited	Well suited	Well suited	Well suited
OnD	Poorly suited	Suited	Well suited	Well suited
Onota:				
OoE	Not suited	Poorly suited	Well suited	Well suited
For Chippeny part, see Chippeny series.				
OrB	Well suited	Well suited	Well suited	Well suited
For Deerton part, see Deerton series.				
OrD	Poorly suited	Suited	Well suited	Well suited
For Deerton part, see Deerton series.				
Otisco: OtB	Not suited	Poorly suited	Poorly suited	Poorly suited
Pickford: Pc	Not suited	Not suited	Poorly suited	Suited
Pickford, moderately wet: PfA, PkA	Suited	Suited	Suited	Suited
For Pickford part of PkA, see Pickford series.				
Rifle	Not suited	Not suited	Not suited	Not suited
Mapped only with Carbondale and Lupton series.				

wildlife habitat and for kinds of wildlife—Continued

Elements of wildlife habitat—Continued				Kinds of wildlife		
Coniferous woody plants	Wetland food and cover plants	Shallow-water developments	Excavated ponds	Open-land	Woodland	Wetland
Suited	Not suited	Well suited	Well suited	Poorly suited	Well suited	Poorly suited.
Suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Not suited	Not suited	Not suited	Not suited	Not suited	Not suited	Not suited.
Suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Suited	Not suited	Not suited	Not suited	Poorly suited	Well suited	Not suited.
Poorly suited	Suited	Well suited	Well suited	Not suited	Not suited	Well suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Not suited	Well suited	Well suited	Well suited	Not suited	Not suited	Well suited.
Poorly suited	Poorly suited	Suited	Suited	Poorly suited	Not suited	Poorly suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Poorly suited	Suited	Not suited.
Well suited	Well suited	Suited	Not suited	Poorly suited	Suited	Suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Poorly suited	Suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Suited	Poorly suited	Suited	Suited	Poorly suited	Not suited	Poorly suited.
Well suited	Suited	Well suited	Well suited	Poorly suited	Suited	Suited.
Suited	Suited	Suited	Suited	Suited	Poorly suited	Poorly suited.
Not suited	Not suited	Well suited	Well suited	Not suited	Not suited	Well suited.

TABLE 4.—*Suitability of the soils for elements of*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woody plants
Roscommon: Rc, RkB For Kalkaska part of RkB, see Kalkaska series.	Not suited	Poorly suited	Poorly suited	Not suited
Rousseau:				
RoB, RoD	Not suited	Poorly suited	Poorly suited	Poorly suited
RsD	Not suited	Poorly suited	Poorly suited	Poorly suited
Rubicon: RuB, RuD, RuE	Not suited	Poorly suited	Poorly suited	Poorly suited
Ruse: Rv	Not suited	Poorly suited	Poorly suited	Suited
Saugatuck: ScA	Not suited	Poorly suited	Poorly suited	Poorly suited
Shelldrake: ShB	Not suited	Not suited	Poorly suited	Poorly suited
Skanee: SkB	Suited	Suited	Suited	Well suited
Steuben:				
StB	Well suited	Well suited	Suited	Well suited
StD	Poorly suited	Suited	Suited	Well suited
Summerville: SuA	Poorly suited	Poorly suited	Suited	Suited
Sundell: SvA	Suited	Suited	Suited	Well suited
Sundell, sandy variant: SwA	Suited	Suited	Suited	Well suited
Tacoosh Mapped only with Cathro soils.	Not suited	Poorly suited	Not suited	Not suited
Tawas: Ta	Not suited	Poorly suited	Not suited	Not suited
Trenary:				
TrA, TrB	Well suited	Well suited	Well suited	Well suited
TrC	Suited	Well suited	Well suited	Well suited
TrD	Poorly suited	Suited	Well suited	Well suited
Wainola: WaA	Suited	Suited	Suited	Well suited
Wallace: WlB, WlD	Not suited	Poorly suited	Poorly suited	Poorly suited
Wheatley: Wm	Not suited	Not suited	Poorly suited	Not suited
Yalmer:				
YaB	Suited	Suited	Well suited	Suited
YaD	Poorly suited	Suited	Well suited	Suited

4. Locate sources of sand, gravel, and other material for use in construction.
5. Correlate pavement performance with the soil mapping units and thus develop information that will be useful in designing and maintaining the pavements.
6. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
7. Determine suitability of soils for movement of vehicles and construction equipment.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

It should be emphasized that the interpretations made in this soil survey are not a substitute for the sampling and testing needed at a site chosen for a specific engineering work that involves heavy loads or at a site where excavations are to be deeper than the depths of the layers here reported. The estimates reported are generally to depths of about 5 feet, and they normally do not apply to greater depths. Nevertheless, by using this survey an engineer can select and concentrate on those soil units most important for his proposed kind of construction, and in this manner he can reduce the number of soil samples taken for laboratory testing and complete an adequate soil investigation at minimum cost.

The soil mapping units shown on the maps in this survey may include small areas of a different soil material. These included soils may be as much as 2 acres in size. They are too small to be mapped separately and generally are not significant to the farming in the area but may be important in engineering planning.

Information of value in planning engineering work is given throughout the text, particularly in the sections,

wildlife habitat and for kinds of wildlife—Continued

Elements of wildlife habitat—Continued				Kinds of wildlife		
Coniferous woody plants	Wetland food and cover plants	Shallow-water developments	Excavated ponds	Open-land	Woodland	Wetland
Well suited	Not suited	Well suited	Well suited	Poorly suited	Well suited	Poorly suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Well suited	Well suited	Suited	Not suited	Poorly suited	Suited	Suited.
Well suited	Poorly suited	Suited	Suited	Poorly suited	Not suited	Poorly suited.
Suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Suited	Suited	Suited	Suited	Well suited	Suited	Suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Suited	Not suited	Not suited	Not suited	Poorly suited	Suited	Not suited.
Poorly suited	Suited	Not suited	Not suited	Well suited	Suited	Suited.
Suited	Suited	Not suited	Not suited	Well suited	Suited	Suited.
Poorly suited	Suited	Well suited	Well suited	Not suited	Not suited	Well suited.
Poorly suited	Suited	Well suited	Well suited	Not suited	Not suited	Well suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Suited	Suited	Not suited.
Suited	Suited	Suited	Suited	Well suited	Suited	Suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Well suited	Not suited	Not suited	Not suited	Poorly suited	Poorly suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.
Poorly suited	Not suited	Not suited	Not suited	Well suited	Well suited	Not suited.

"Descriptions of the Soils" and "Formation and Classification of Soils."

Some of the terms used by the scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, and sand—may have special meaning in soil science. These and other special terms used in the soil survey are defined in the Glossary at the back of this survey. Most of the information about engineering is given in tables 5 and 6.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system, used by the SCS engineers, Department of Defense, and others (*10*), and the AASHTO system, adopted by the American Association of State Highway and Transportation Officials (*1*).

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, ML–CL.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils

599-811—77——7

TABLE 5.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The soils in for referring to other series that appear in the first column of this table. The sign > means more than; the sign <

Soil series and map symbols	Soil hydrologic group	Depth to—		Depth from surface	USDA texture	Classification	
		Bedrock	Seasonal high water table			Unified	AASHTO
		Inches	*Feet*	*Inches*			
Alluvial land: Ad. Too variable to be rated.							
Alpena: AlC	B	[1]>60	>4	0–7	Gravelly sandy loam	SM	A–2
				7–60	Very gravelly sand [2]	SP	A–1
Angelica*	D to C	[1]>60	<1	0–4	Loam	ML–CL	A–4
Mapped only with Ensley soils.				4–15	Sandy loam, loam, or light sandy clay loam.	SM, SC, or CL	A–4 or A–6
				15–60	Loam or silt loam [3]	ML or CL	A–4 or A–6
Au Gres: AuB	C to A	>60	1–2	0–12	Sand	SP or SP–SM	A–3
				12–60	Sand	SP	A–3
Au Gres, gravelly subsoil variant: AvA	C to A	>60	1–2	0–12	Loamy sand	SM	A–2
				12–20	Loamy sand or sand	SM or SP–SM	A–2
				20–60	Stratified sand and gravel [3]	SP–SM or SP	A–3 or A–1
Blue Lake: BlB, BlD, BlE	A	>60	>4	0–25	Sand	SP–SM or SM	A–2
				25–32	Layers of sand, loamy sand, or sandy loam.	SM and SP–SM	A–2
				32–60	Sand	SP	A–3
Bohemian: BoB, BoD	B	>60	[4]>4	0–5	Fine sandy loam	SM or ML	A–4
				5–28	Very fine sandy loam, fine sandy loam, or silt loam.	SM or ML	A–4
				28–60	Stratified loam, silt loam, and very fine sand.	ML and SM	A–4 and A–2
Borrow pits: Bp. Too variable to be rated.							
Bowers: BrA	C	>60	1–2	0–11	Silt loam	ML	A–4
				11–18	Silty clay loam	CL	A–6
				18–60	Stratified silt, silt loam, silty clay loam, silty clay.	ML or CL	A–6 or A–4
Brevort: Bs	B	[1] 60	<1	0–2	Mucky loamy sand	SM	A–2
				2–22	Sand or loamy sand	SM or SP–SM	A–2 or A–3
				22–60	Loam [5]	ML	A–4
Brimley: BtA	B	>60	1–2	0–6	Fine sandy loam	SM or ML–CL	A–4
				6–22	Very fine sandy loam, silt loam, loam.	ML or CL, or layers of SM and ML	A–4 or A–6
				22–60	Stratified silt, silt loam, very fine sand.	Layers of ML and SM or ML–CL	A–4 or A–2

See footnotes at end of table.

significant to engineering

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions means less than. Absence of data indicates that the soil is too variable to be rated or that no estimate was made]

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 200 (0.074 mm)					Uncoated steel	Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
95–100	75–80	15–30	6. 0–20	0. 10	7. 4–7. 8	Low	Low	Low.
65–80	60 75	0–5	>20	0. 02	7. 9–8. 4	Low	Low	Low.
100	100	60–70	0. 6–2. 0	0. 20	6. 1–6. 5	Low	High	Low.
100	95–100	45–80	0. 6–2. 0	0. 18	6. 6–7. 3	Low to moderate	High	Low.
80–95	75–90	60–80	0. 2–0. 6	0. 16	7. 4–7. 8	Low	High	Low.
100	95–100	0–10	6. 0–20	0. 06	4. 5–5. 0	Low	Low	High.
100	95–100	0–5	6. 0–20	0. 04	5. 6–6. 5	Low	Low	Moderate.
95–100	95–100	15–25	6. 0–20	0. 05–0. 10	6. 1–6. 5	Low	Low	Moderate.
95–100	90–100	10–25	6. 0–20	0. 05–0. 10	6. 1–7. 3	Low	Low	Moderate.
55–80	50–70	0–10	6. 0–20	0. 02	7. 4–7. 8	Low	Low	Low.
100	100	10–20	6. 0–20	0. 05–0. 10	4. 5–6. 5	Low	Low	Moderate.
100	100	10–25	6. 0–20	0. 10	5. 6–6. 0	Low	Low	Moderate.
100	100	0–5	>20	0. 04	5. 6–6. 0	Low	Low	Moderate.
100	100	40–65	0. 6–2. 0	0. 16	4. 5–6. 5	Low	Moderate	Moderate.
100	100	40–90	0. 6–2. 0	0. 18	5. 1–6. 5	Low	Moderate	Moderate.
100	95–100	30–90	0. 6–2. 0	0. 16	7. 4–7. 8	Low	Moderate	Low.
100	100	70–95	0. 6–2. 0	0. 16	6. 1–6. 5	Low	High	Low.
100	100	90–95	0. 2 0. 6	0. 20	6. 6–7. 3	Moderate	High	Low.
100	100	60–90	0. 2–0. 6	0. 16	7. 4–7. 8	Moderate	High	Low.
100	100	15–35	6. 0–20	0. 05	6. 1–6. 5	Low	High	Moderate.
95–100	95–100	5–30	6. 0–20	0. 05	6. 1–7. 3	Low	High	Moderate.
85–95	80–95	60–75	0. 2–0. 6	0. 12	7. 4–7. 8	Moderate to low	High	Low.
100	100	40–65	0. 6–2. 0	0. 16	5. 6–6. 0	Low	High	Moderate.
100	100	45–95	0. 6–2. 0	0. 18	5. 6–6. 5	Low	High	Moderate.
100	95–100	30–70	0. 6–2. 0	0. 16	7. 4–7. 8	Low	High	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Soil hydrologic group	Depth to—		Depth from surface	USDA texture	Classification	
		Bedrock	Seasonal high water table			Unified	AASHTO
		Inches	*Feet*	*Inches*			
Bruce, coarse variant: Bu	D to B	>60	<1	0–5	Mucky fine sandy loam.	SM or ML–CL	A–2 or A–4
				5–60	Stratified loamy very fine sand, lenses of loamy sand and silt loam.	SM or layers of ML and SM	A–2 or A–4
Burt: BwC	D	10–20	<1	0–5	Mucky sandy loam	SM	A–2 or A–4
				5–17	Sand [2]	SP–SM	A–2
				17	Sandstone bedrock.		
*Carbondale: Cb For Lupton and Rifle parts, see Lupton and Rifle series.	D to A	>60	0	0–4	Mucky peat	Pt	
				4–60	Muck or mucky peat	Pt	
*Cathro: Ch, Ck For Tacoosh part of Ck, see Tacoosh series.	D to B	[1] >60	0	0–4	Mucky peat	Pt	
				4–23	Muck or mucky peat	Pt	
				23–60	Sandy loam	SM	A–2 or A–4
Charlevoix: ClA	B	[1] >60	1–2	0–19	Sandy loam	SM	A–2 or A–4
				19–29	Loam [5]	SM, SC, ML or CL	A 6 or A 4
				29–60	Sandy loam [3]	SM	A–2 or A–4
Chatham: CmA, CmB, CmD	B	[1] >60	[6] >3	0–13	Fine sandy loam	SM or ML	A–2 or A–4
				13–23	Sandy loam	SM	A–2 or A–4
				23–60	Gravelly loamy sand [2]	SM or SP–SM	A–2
Chippeny: Cn	D	20–51	0	0–20	Muck	Pt	
				20–28	Silty clay loam	CL	A–6
				28	Limestone bedrock.		
Croswell: CrA	A	>60	2–5	0–60	Sand	SP or SP–SM	A–3
*Dawson: Da, Dd For Greenwood part of Dd, see Greenwood series.	D to A	>60	0	0–8	Peat	Pt	
				8–38	Muck	Pt	
				38–40	Silt loam	ML	A–4
				40–60	Sand	SP–SM or SP	A–3
*Deerton: DeB, DeD, DlB For Burt part of DlB, see Burt series.	B	20–40	[6] >3	0–8	Sand	SP–SM or SM	A–2 or A–3
				8–24	Sand or loamy sand [5]	SP–SM or SM	A–2 or A–3
				24	Sandstone bedrock.		
Deford: Dm	D to A	>60	<1	0–60	Loamy fine sand	SM	A–2
Duel: DuB	B	20 to 40	>3	0–8	Loamy sand	SP–SM or SM	A–2
				8–28	Sand	SM or SP–SM	A–2
				28–31	Loamy sand [5]	SM	A–2
				31	Limestone bedrock.		
East Lake: EaB	A	>60	[4] >4	0–36	Sand	SP–SM or SM	A–2 or A–3
				36–60	Stratified sand and gravel. [6]	SP or SP–SM	A–1, A–2 or A–3
East Lake, acid variant: EcB, EcD.	A	>60	[4] >4	0–26	Loamy sand	SM	A–2
				26–60	Stratified gravel and sand. [5]	SP or SP–SM	A–1, A–2 or A–3
Eastport: EdB, EeB For Roscommon part of EeB, see Roscommon series.	A	[1] >60	[4] >4	0–19	Sand	SP	A–3
				19–60	Sand	SP	A–3

See footnotes at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to -	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 200 (0.074 mm)					Uncoated steel	Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
100	100	30–55	0. 6–2. 0	0. 18	6. 1–7. 3	Low	High	Low.
100	95–100	30–60	0. 6–2. 0	0. 16	6. 6–8. 4	Low	High	Low.
90–100	90–100	15–50	6. 0–20	0. 08	6. 1–6. 5	Low	High	Moderate.
90–100	90–100	5–10	6. 0–20	0. 04	6. 1–6. 5	Low	High	Moderate.
			10. 0–20	0. 50	6. 6–7. 3	Variable	High	Low.
			6. 0–10	0. 50	6. 6–7. 8	Variable	High	Low.
			6. 0–10	0. 50	5. 6–7. 8	Variable	High	Moderate.
			6. 0–20	0. 50	5. 6–7. 8	Variable	High	Moderate.
95–100	90–100	20–45	0. 2–0. 6	0. 14	7. 4–7. 8	Low	High	Low.
95–100	90–100	25–45	0. 6–2. 0	0. 12	6. 1–6. 5	Low	Moderate	Moderate.
95–100	90–100	45–65	0. 6–2. 0	0. 15	6. 6–7. 3	Low	High	Low.
80–95	75–95	20–45	0. 6–2. 0	0. 12	7. 4–7. 8	Low	Moderate	Low.
95–100	90–100	30–55	2. 0–6. 0	0. 12	7. 4–7. 8	Low	Low	Low.
95–100	90–100	30–40	2. 0–6. 0	0. 14	7. 4–7. 8	Low	Low	Low.
80–95	65–80	10–20	6. 0–20	0. 05–0. 1	7. 8–8. 4	Low	Low	Low.
			6. 0–10	0. 50	7. 4–7. 8	Variable	High	Low.
100	100	85–95	0. 2–0. 6	0. 18	7. 4–7. 8	Low	High	Low.
100	95–100	0–5	6. 0–20	0. 04	4. 5–6. 5	Low	Low	Moderate to high.
			20–30	0. 50	<4. 5	Variable	High	High.
			6. 0–10	0. 50	<4. 5	Variable	High	High.
95–100	95–100	70–85	2. 0–6. 0	0. 18	<4. 5	Low to moderate	High	High.
100	95–100	0–10	6. 0–20	0. 04	<4. 5	Low	High	High.
95–100	95–100	5–15	6. 0–20	0. 08	<4. 5	Low	Low	High.
95–100	95–100	5–25	6. 0–20	0. 05	4. 5–5. 0	Low	Low	High.
100	100	20–35	6. 0–20	0. 08	5. 6–7. 3	Low	High	Low to moderate.
90–100	85–95	10–20	6. 0–20	0. 08	6. 1–6. 5	Low	Low	Moderate.
90–100	85–95	10–30	6. 0–20	0. 08	6. 1–7. 3	Low	Low	Low.
90–100	85–95	15–35	6. 0–20	0. 08	7. 9–8. 4	Low	Low	Low.
100	95–100	5–15	6. 0–20	0. 08	6. 1–6. 5	Low	Low	Moderate.
85–95	40–90	0–10	>20	0. 02	7. 4–8. 4	Low	Low	Low.
85–95	80–95	15–35	6. 0–20	0. 10	5. 6–6. 0	Low	Low	Moderate.
60–90	40–80	0–10	>20	0. 02	5. 6–6. 0	Low	Low	Moderate.
100	95–100	0–5	6. 0–20	0. 05	5. 6–7. 3	Low	Low	Moderate.
90–100	85–100	0–5	6. 0–20	0. 04	7. 4–8. 4	Low	Low	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Soil hydrologic group	Depth to—		Depth from surface	USDA texture	Classification	
		Bedrock	Seasonal high water table			Unified	AASHTO
		Inches	*Feet*	*Inches*			
Emmet: EmA, EmB, EmC	B	[1] >60	[6] >3	0–10	Sandy loam	SM	A–2 or A–4
				10–26	Fine sandy loam or sandy loam.	SM	A–2 or A–4
				26–33	Light sandy clay loam	SC or CL	A–4 or A–6
				33–60	Sandy loam [3]	SM	A–2 or A–4
Ensign: EnA	D	10–20	1–2	0–6	Fine sandy loam	SM or ML	A–4
				6–17	Loam or light loam [2]	ML	A–4
				17	Limestone bedrock.		
Ensley: Es	D to B	[1] >60	>1	0–4	Sandy loam	SM	A–2 or A–4
For Angelica part, see Angelica series.				4–14	Sandy loam or fine sandy loam.	SM	A–2 or A–4
				14–20	Light sandy clay loam	ML–CL or SC, SM	A–4 or A–6
				20–60	Sandy loam [3]	SM	A–2 or A–4
Fairport: FaA, FaB	C	20–40	[6] >3	0–9	Silt loam	ML	A–4
				9–28	Silty clay loam [3]	CL	A–6
				28	Limestone bedrock.		
Gilchrist: GcB	B	[1] >60	[6] >3	0–30	Sand	SP–SM	A–3
				30–60	Sandy loam [3]	SM	A–2
Grayling: GrB, GrD	A	>60	>4	0–60	Sand	SP or SP–SM	A–3
Greenwood: Gw	D to A	>60	0	0–10	Peat	Pt	----------
				10–62	Mucky peat	Pt	----------
Ioseo: IoB	B	>60	1–2	0–29	Sand	SP or SP–SM	A–3
				29–60	Loam or clay loam [5]	ML or CL	A–4 or A–6
Kalkaska: KaB, KaD, KaE	A	>60	[4] >4	0–10	Sand	SP or SP–SM	A–3
				10–60	Sand	SP	A–3
Karlin: KdB, KdD	A	>60	[4] >4	0–17	Sandy loam	SM	A–2 or A–4
				17–22	Loamy sand	SM	A–2
				22–60	Sand [3]	SP or SP–SM	A–3
Kawbawgam: KgC	C	20–40	1–2	0–24	Sandy loam	SM	A–2
				24	Sandstone bedrock.		
Kawkawlin: KlA	C	[1] >60	1–2	0–10	Silt loam	ML	A–4
				10–21	Heavy clay loam	CL	A–6
				21–60	Clay loam [3]	CL	A–6
Keweenaw: KnB, KnD	A	>60	>4	0–32	Loamy sand [5]	SM	A–2
				32–39	Fine sandy loam	SM	A–2 or A–4
				39–60	Loamy sand	SM	A–2
Kinross: Kr	D to A	>60	<1	0–60	Sand	SP	A–3
Kiva: KsB, KsD	B	[1] >60	>4	0–12	Sandy loam	SM	A–2
				12–22	Gravelly sandy loam	SM	A–2
				22–60	Stratified gravel, sand, and cobbles. [2]	SP or SP–SM	A–1
Lake beaches: Lb	----------	[1] >60					
Too variable to be rated.							
Limestone rock land: Lm	----------	<10					
Too variable to be rated.							

See footnotes at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 200 (0.074 mm)					Uncoated steel	Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
95–100	90–100	25–45	0. 6–2. 0	0. 12	6. 1–6. 5	Low	Low	Moderate.
95–100	90–100	25–45	0. 6–2. 0	0. 12	6. 1–6. 5	Low	Low	Moderate
95–100	90–100	40–60	0. 6–2. 0	0. 15	6. 1–6. 5	Low	Low	Low.
80–95	75–95	20–45	0. 6–2. 0	0. 12	7. 9–8. 4	Low	Low	Low.
90–95	80–95	40–55	0. 6–2. 0	0. 14	7. 4–7. 8	Low	Moderate	Low.
90–95	80–95	55–65	0. 6–2. 0	0. 14	7. 4–8. 4	Low	High	Low.
95–100	90–100	25–45	0. 6–2. 0	0. 14	6. 1–6. 5	Low	High	Moderate.
95–100	90–100	25–45	0. 6 2. 0	0. 14	6. 1–6. 5	Low	High	Moderate.
95–100	90–100	40–60	0. 6–2. 0	0. 16	6. 1–6. 5	Low	High	Low.
85–95	80–95	20–45	0. 6–2. 0	0. 12	7. 4–7. 8	Low	High	Low.
95–100	95–100	70–85	0. 6–2. 0	0. 18	6. 1–6. 5	Low to moderate	Moderate	Low.
95–100	95–100	70–85	0. 2–0. 6	0. 18	5. 6–7. 8	Moderate	High	Low.
95–100	95–100	5–10	6. 0–20	0. 08	5. 1–7. 8	Low	Low	Moderate.
85–95	80–95	20–35	0. 6–2. 0	0. 12	7. 4–7. 8	Low	Low	Low.
100	95–100	0–10	>20	0. 04	4. 5–6. 0	Low	Low	Moderate to high.
			20–30	0. 50	<4. 5	Variable	High	High.
			10–20	0. 50	<4. 5	Variable	High	High.
95–100	95–100	0–10	6. 0–20	0. 06	4. 5–5. 5	Low	Low	High.
85–95	80–95	60–70	0. 2–0. 6	0. 18	6. 1–8. 4	Low to moderate	High	Low.
100	95–100	0–10	6. 0–20	0. 06	4. 5–6. 0	Low	Low	Moderate.
100	95–100	0–5	>20	0. 04	4. 5–6. 0	Low	Low	High.
95–100	95–100	20–45	2. 0–6. 0	0. 12	5. 1–6. 0	Low	Low	Moderate.
95–100	95 100	15–30	2. 0–6. 0	0. 12	5. 6–6. 0	Low	Low	Moderate.
95–100	75–100	0–10	6. 0–20	0. 02	5. 6–6. 0	Low	Low	Moderate.
95–100	90–100	25–35	0. 6–2. 0	0. 14	4. 5–5. 5	Low	Moderate	High.
100	95–100	70–90	0. 6–2. 0	0. 18	6. 6–7. 3	Low	High	Low.
95–100	95–100	70–80	0. 2–0. 6	0. 16	6. 6–7. 8	Moderate	High	Low.
90–95	85 95	70 -80	0. 2 -0. 6	0. 16	7. 9–8. 4	Moderate	High	Low.
100	95–100	15–30	6. 0–20	0. 08	4. 5–5. 5	Low	Low	High.
100	95–100	25–45	2. 0–6. 0	0. 10	5. 1–5. 5	Low	Low	Moderate.
90–100	85–95	15–30	6. 0–20	0. 08	5. 6–6. 0	Low	Low	Moderate.
100	100	0–5	>20	0. 04	4. 5–5. 5	Low	High	High.
85–95	75–95	15–35	0. 6–2. 0	0. 12	6. 1–6. 5	Low	Low	Moderate.
80–95	60–90	15–35	0. 6–2. 0	0. 12	6. 1–6. 5	Low	Low	Moderate.
70–90	60–80	0–10	>20	0. 03	7. 9–8. 4	Low	Low	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Soil hydrologic group	Depth to —		Depth from surface	USDA texture	Classification	
		Bedrock	Seasonal high water table			Unified	AASHTO
		Inches	*Feet*	*Inches*			
*Longrie: LoA, LoB, LsD. For Summerville part of LsD, see Summerville series.	C	20–40	[6] >3	0–18	Sandy loam [5]	SM or ML	A–2 or A–4
				18–28	Loam [5]	ML or CL	A–6 or A–4
				28	Limestone bedrock.		
*Lupton. Mapped only with Carbondale and Rifle soils.	D to A	>60	0	0–73	Muck or mucky peat	Pt	
Made land: Ma. No valid estimates can be made.							
Mancelona: McB, McD	A	>60	>4	0–20	Loamy sand	SM	A–2
				20–24	Gravelly clay loam	SC or CL	A–4 or A–6
				24–60	Stratified sand and gravel.	SP–SM or SP	A–3 or A–1
Marsh: Mh. No valid estimates can be made.							
Melita: MlB	B	>60	[4] >4	0–44	Sand	SP or SM	A–2 or A–3
				44–60	Heavy loam and loam [3].	CL or ML–CL	A–4 or A–6
Menominee: MnB, MnD	B	>60	[6] >3	0–10	Loamy sand	SM or SP–SM	A 2 or A–3
				10–30	Sand	SM or SP–SM	A–2 or A–3
				30–60	Fine sandy loam to loam. [5]	ML–CL or CL	A–4 or A–6
Munising: MuB, MuD, MuE	B	[1] >60	[6] >3	0–16	Sandy loam	SM	A–2 or A–4
				16–46	Sandy loam or light loamy sand (fragipan) [5]	SM	A–2
				46–60	Sandy loam [5]	SM	A–2
Nahma: Nh	C	20–40	<1	0–5	Loam [3]	ML	A 4
				5–29	Fine sandy loam or loam.[3]	SM or ML	A–2 or A–4
				29+	Limestone bedrock.		
Nester: NsA, NsB	C	[1] >60	[6] >3	0–9	Silt loam	ML or ML–CL	A–4
				9–20	Silty clay loam [3]	CL	A–6
				20–60	Silty clay loam [3]	CL	A–6
Onaway: OnA, OnB, OnC, OnD	B	[1] >60	[6] >3	0–14	Fine sandy loam and sandy loam.	SM or ML	A–4
				14–22	Clay loam or heavy clay loam.	CL or ML–CL	A–6 or A–4
				22–60	Loam [5]	ML or ML–CL	A–4
*Onota: OoE, OrB, OrD. For Chippeny part of OoE, see Chippeny series; for Deerton parts of OrB, OrD, see Deerton series.	C	20–40	[6] >3	0–3	Sandy loam	SM	A–2
				3–28	Sandy loam or loamy sand.	SM	A–2
				28	Sandstone bedrock.		

See footnotes at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 200 (0.074 mm)					Uncoated steel	Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
90–100	85–95	25–55	0. 6–2. 0	0. 14	6. 6–7. 3	Low	Low	Low.
90–100	85–95	55–70	0. 6–2. 0	0. 15	7. 4–8. 4	Low	Moderate	Low.
			10–20	0. 50	6. 1–7. 3	Variable	High	Low.
95–100	95–100	10–30	2. 0–6. 0	0. 10	6. 6–7. 3	Low	Low	Low.
95–100	65–80	45–70	2. 0–6. 0	0. 10–0. 14	6. 6–7. 3	Low	Low	Low.
55–80	50–75	0 10	6. 0 20	0. 02	7. 9–8. 4	Low	Low	Low.
95–100	95–100	0–15	6. 0–20	0. 05	5. 6 6. 5	Low	Low	Moderate.
95–100	90–100	60–80	0. 2–0. 6	0. 18	6. 1–7. 8	Moderate	Low	Low.
95–100	95–100	5–25	6. 0–20	0. 08	4. 5–6. 5	Low	Low	Moderate to high.
95–100	95–100	5–15	6. 0–20	0. 08	4. 5–6. 5	Low	Low	Moderate to high.
85–95	80–95	60–80	0. 2–0. 6	0. 18	5. 6–7. 8	Moderate to low	Low	Low.
95–100	90–100	25–45	0. 6–2. 0	0. 14	4. 5–5. 5	Low	Low	High.
95–100	90–100	25 35	0. 06–0. 6	(7)	5. 6–6. 0	Low	Low	Moderate.
80–95	75–95	20–35	0. 6–2. 0		5. 6–6. 0	Low	Low	Moderate.
95–100	90–100	60 75	0. 6 2. 0	0. 16	6. 6–7. 3	Low	High	Low.
90–95	85–95	30–60	0. 6–2. 0	0. 14	6. 6–8. 4	Low	High	Low.
95–100	95–100	70–90	0. 6–2. 0	0. 18	6. 1–6. 5	Low	Moderate	Low.
95–100	95–100	70–90	0. 2–0. 6	0. 16	6. 6–7. 3	High to moderate.	High	Low.
90–95	85–95	70–90	0. 2–0. 6	0. 16	7. 9–8. 4	Moderate	High	Low.
100	95–100	40–70	0. 6–2. 0	0. 16	6. 1–7. 3	Low	Low	Low.
95–100	95–100	65–80	0. 2–0. 6	0. 18	7. 4–7. 8	Moderate to low	Low	Low.
90–95	85–95	55–70	0. 6–2. 0	0. 16	7. 9–8. 4	Low	Low	Low.
90–100	90–100	25–35	0. 6–2. 0	0. 14	5. 1–5. 5	Low	Low	High.
90–100	90–100	15–35	0. 6–2. 0	0. 14	5. 1–5. 5	Low	Low	High.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Soil hydrologic group	Depth to—		Depth from surface	USDA texture	Classification	
		Bedrock	Seasonal high water table			Unified	AASHTO
		Inches	*Feet*	*Inches*			
Otisco: OtB	A	>60	1–2	0–7	Loamy sand	SP–SM or SM	A–2
				7–24	Sand	SP–SM or SM	A–2 or A–3
				24–35	Layers of sand, loamy sand, and fine sandy loam.	Layers of SM and SP–SM	A–2 or A–3
				35–60	Sand or loamy sand	SP–SM or SM	A–2 or A–3
Pickford: Pc	D	>60	<1	0–4	Silt loam	ML	A–4
				4–9	Loamy fine sand	SM	A–4 or A–2
				9–18	Silty clay	CH	A–7
				18–60	Silty clay	CH	A–7
*Pickford, moderately wet: PfA, PkA. For Pickford part of PkA, see Pickford series.	D	>60	1–2	0–8	Silt loam	ML	A–4
				8–14	Silty clay	CH	A–7
				14–60	Stratified silty clay	CH	A–7
Rifle Mapped only with Carbondale and Lupton soils.	D to A	>60	0	0–4	Peat	Pt	----------
				4–60	Mucky peat	Pt	----------
*Roscommon: Rc, RkB For Kalkaska part of RkB, see Kalkaska series.	D to A	>60	<1	0–60	Sand	SP	A–3
Rousseau: RoB, RoD, RsD	A	>60	[4] >4	0–60	Fine sand	SM	A–2
Rubicon: RuB, RuD, RuE	A	>60	>4	0–60	Sand	SP	A–3
Ruse: Rv	D	10–20	<1	0–7	Silt loam	ML	A–4
				7–11	Sandy loam	SM or ML	A–2 or A–4
				11	Limestone bedrock.		
Saugatuck: ScA	C	>60	<2	0–15	Sand	SP–SM or SP	A–3
				15–32	Cemented sand (ortstein).	SP or SP–SM	A–3
				32–60	Sand	SP or SP–SM	A–3
Shelldrake: ShB	A	>60	[4] >4	0–60	Sand	SP	A–3
Skanee: SkB	C	>60	1–2	0–5	Sandy loam	SM	A–2 or A–4
				5–14	Fine sandy loam	SM	A–2 or A–4
				14–33	Sandy loam to loamy sand (fragipan).	SM	A–2 or A–4
				33–60	Sandy loam [5]	SM	A–2
Steuben: StB, StD	B	>60	[6] >3	0–19	Fine sandy loam	SM	A–4
				19–38	Loamy fine sand to fine sandy loam (fragipan).	SM	A–2 or A–4
				38–60	Sand	SP–SM or SP	A–3
Summerville: SuA	C	10–20	([6])	0–15	Fine sandy loam [5]	SM or ML	A–4
				15	Limestone bedrock.		
Sundell: SvA	C	20–40	1–2	0–8	Fine sandy loam	SM or ML	A–4
				8–26	Loam	ML	A–4
				26	Limestone bedrock.		
Sundell, sandy variant: SwA	C	20–40	1–2	0–35	Loamy fine sand	SM	A–2
				35	Limestone bedrock.		

See footnotes at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 200 (0.074 mm)					Uncoated steel	Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
100	100	10–20	6. 0–20	0. 10	5. 6–6. 0	Low	Low	Moderate.
100	100	5–15	6. 0–20	0. 10	5. 6–6. 0	Low	Low	Moderate.
100	100	5–35	2. 0–6. 0	0. 08	6. 1–7. 3	Low	Low	Low.
100	100	5–25	6. 0–20	0. 05	7. 4–7. 8	Low	Low	Low.
95–100	95–100	70–90	0. 6–2. 0	0. 16	6. 6–7. 3	Low	High	Low.
95–100	95–100	15–45	2. 0–6. 0	0. 10–0. 16	6. 6–7. 8	Low	High	Low.
100	95–100	90–95	<0. 06	0. 16	7. 4 7. 8	High	High	Low.
100	95–100	90–95	<0. 06	0. 16	7. 9–8. 4	High	High	Low.
100	100	70–90	0. 2–0. 6	0. 18	6. 1–6. 5	Low	High	Low.
100	100	90 95	<0. 06	0. 16	6. 6–7. 3	High	High	Low.
100	95–100	90–95	<0. 06	0. 16	7. 9–8. 4	High	High	Low.
			20–30	0. 50	6. 6–7. 8	Variable	High	Low.
			6. 0–20	0. 50	6. 6 7. 8	Variable	High	Low.
100	95–100	0–5	6. 0–20	0. 04	6. 1–7. 3	Low	High	Low.
100	100	15–30	6. 0–20	0. 06	5. 1–6. 0	Low	Low	Moderate.
100	95–100	0–5	>20	0. 04	4. 5–6. 5	Low	Low	Moderate to high.
95 100	90–100	60–75	0. 6–2. 0	0. 16	7. 4–7. 8	Moderate	High	Low.
95–100	90–100	30–65	0. 6–2. 0	0. 14	7. 9–8. 4	Low	High	Low.
100	95–100	0–10	6. 0–20	0. 06	4. 5 5. 6	Low	Low	High.
100	95–100	0–10	0. 06–0. 2	0. 04	5. 1–5. 5	Low	Low	High.
100	95–100	0–10	6. 0–20	0. 04	5. 6–6. 0	Low	Low	Moderate.
100	95–100	0–5	>20	0. 04	4. 5–6. 0	Low	Low	Moderate to high.
95–100	90–100	25–40	0. 6–2. 0	0. 14	4. 5–5. 0	Low	Moderate	High.
95–100	90–100	25–40	0. 6–2. 0	0. 17	4. 5–5. 0	Low	Moderate	High.
95–100	90–100	15–40	0. 06–0. 6	0. 08	4. 5–5. 5	Low	Moderate	High.
80–95	75–95	20–35	0. 6–2. 0	0. 08	5. 1–5. 5	Low	Moderate	High.
95–100	90–100	35–50	0. 6–2. 0	0. 12	4. 5–5. 5	Low	Low	High.
95–100	90–100	25–45	0. 06–0. 6	0. 08	5. 1–5. 5	Low	Low	High.
80 100	75–100	0–10	6. 0–20	0. 02	5. 1–6. 0	Low	Low	Moderate.
90–95	80–95	40–60	0. 6–2. 0	0. 14	7. 4–8. 4	Low	Low	Low.
90–100	85–95	40–55	0. 6–2. 0	0. 16	6. 1–6. 5	Low	Moderate	Moderate.
90–100	85–95	60–75	0. 6–2. 0	0. 16	6. 1–8. 4	Low	High	Low.
100	100	15–25	6. 0–20	0. 11	6. 6–7. 8	Low	Low	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Soil hydrologic group	Depth to—		Depth from surface	USDA texture	Classification	
		Bedrock	Seasonal high water table			Unified	AASHTO
		Inches	*Feet*	*Inches*			
Tacoosh	D	[1]>60	0	0–8	Muck	Pt	
Mapped only with Cathro soils.				8–40	Mucky peat	Pt	
				40–60	Sandy loam	SM	A–4 or A–2
Tawas: Ta	D to A	>60	0	0–4	Mucky peat	Pt	
				4–18	Muck	Pt	
				18–60	Sand	SP–SM or SP	A–3
Trenary: TrA, TrB, TrC, TrD	B	[1]>60	[6]>3	0–17	Fine sandy loam	SM	A–2 or A–4
				17–26	Sandy loam [5](fragipan)	SM	A–2 or A–4
				26–37	Sandy clay loam	SC or CL	A–6
				37–60	Sandy loam [5]	SM or ML–CL	A–2 or A–4
Wainola: WaA	A	>60	1–2	0–60	Fine sand	SM	A–2
Wallace: WlB, WlD	B	>60	[4]>4	0–7	Sand	SP–SM	A–3
				7–30	Cemented sand (ortstein).	SP–SM	A–3
				30–60	Sand	SP	A–3
Wheatley: Wm	D to A	>60	<1	0–5	Mucky loamy sand	SM	A–2
				5–34	Sand [3]	SM or SP–SM	A–2
				34–60	Stratified sand and gravel.[3]	SP	A–3 or A–1
Yalmer: YaB, YaD	B	>60	[6]>3	0–24	Sand	SM or SP–SM	A–2 or A–3
				24–36	Sandy loam (fragipan)	SM	A–2
				36–60	Sandy loam [3]	SM	A–2

[1] In places bedrock is within a depth of 40 to 60 inches.
[2] Coarse fraction greater than 3 inches is 10 to 30 percent.
[3] Coarse fraction greater than 3 inches is 0 to 5 percent.
[4] Seasonal high water table generally greater than 4 feet. Some moderately well drained areas have seasonally high water table between depths of 2½ and 4 feet.

TABLE 6.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The soils in such mapping units may have

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
Alluvial land: Ad. Too variable to be rated.						
Alpena: AlC	Slight: [3, 4]	Severe: rapid permeability.	Severe: sidewall instability.	Slight where slopes are 0 to 6 percent. Moderate where slopes are more than 6 percent.	Severe: very rapid permeability in substratum; gravelly.	Slight where slopes are 0 to 6 percent. Moderate where slopes are more than 6 percent.
Angelica. Mapped only with Ensley soils.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.
An Gres: AnB	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.	Severe: Very rapid permeability in substratum; sandy.	Moderate: seasonal high water table.

See footnotes at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 200 (0.074 mm)					Uncoated steel	Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
			6. 0–10	0. 50	6. 1–6. 5	Variable	High	Moderate.
			10–20	0. 50	6. 1–7. 3	Variable	High	Low.
95–100	95–100	30–40	0. 6–2. 0	0. 14	7. 4–8. 4	Low to moderate	High	Low.
			10–20	0. 50	5. 6–6. 0	Variable	High	Moderate.
			6. 0–10	0. 50	5. 6–6. 5	Variable	High	Moderate.
100	95–100	0–10	6. 0–20	0. 04	6. 1–6. 5	Low	High	Moderate.
95–100	90–100	30–50	0. 6–2. 0	0. 15	5. 1–6. 0	Low	Moderate	Moderate.
95–100	90–100	30–50	0. 2–0. 6	0. 10	5. 1–5. 5	Low	Moderate	Moderate.
95–100	90–100	40–55	0. 2–0. 6	0. 18	5. 6–6. 0	Low	Moderate	Moderate.
85–95	80–95	30–60	0. 6–2. 0	0. 10	6. 6–8. 4	Low	Moderate	Low.
100	100	15–30	6. 0–20	0. 08	5. 1–6. 5	Low	Low	Moderate.
100	95–100	5–10	6. 0–20	0. 40	4. 5–5. 5	Low	Low	High.
100	95–100	5–10	0. 2–0. 6	0. 40	5. 1–6. 5	Low	Low	Moderate.
100	95–100	0–5	>20	0. 40	6. 1–6. 5	Low	Low	Moderate.
100	100	10–35	6. 0–20	0. 10	6. 1–7. 3	Low	High	Low.
100	95–100	5–15	6. 0–20	0. 05	6. 1–7. 8	Low	High	Low.
60–80	50–75	0–5	>20	0. 02	7. 9–8. 4	Low	High	Low.
100	95–100	5–20	6. 0–20	0. 09	5. 1–5. 5	Low	Low	High.
80–95	75–95	20–35	0. 06–0. 6	[7]	5. 1–5. 5	Low	Low	High.
80–95	75–95	20–35	0. 6–2. 0		5. 1–6. 0	Low	Low	Moderate.

[5] Coarse fraction greater than 3 inches is 0 to 10 percent.

[6] Seasonal high water table generally is at a depth greater than 3 feet. Some moderately well drained areas have a seasonally high water table between depths of 2 and 3 feet.

[7] Available water capacity is not given for the fragipan and underlying layers, because the roots of most plants cannot penetrate these layers, and water is not available to them.

[8] The water table is in the bedrock strata.

engineering properties of the soils

different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [2]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Good	Fair [4]	Poor: gravelly	Rapid seepage [5]	Gravelly material; rapid seepage; difficult to vegetate.	No drainage needed	Very low available water capacity; rapid intake.
Poor: high water table.	Unsuited: no sand	Poor: poorly drained.	High water table; [5] slow seepage.	Fair to poor compaction characteristics.	High water table: moderately slow permeability.	High water table.
Fair: seasonal high water table.	Good: seasonal high water table.	Poor: sandy	Seasonal high water table; rapid seepage.	Sandy material; rapid seepage.	Seasonal high water table; rapid permeability; unstable ditchbanks; flows when wet.	Very low available water capacity; rapid intake; seasonal high water table.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
Au Gres, gravelly subsoil variant: AvA.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.	Severe: rapid permeability; sandy.	Moderate: seasonal high water table.
Blue Lake:						
BlB	Slight [2]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability; sandy.	Slight
BlD	Moderate [3] Slope	Severe: rapid permeability; slope.	Severe: sidewall instability.	Moderate: slope	Severe: rapid permeability; sandy.	Generally moderate: slope. Severe where slopes are more than 6 percent.
BlE	Severe: slope	Severe: rapid permeability; slope.	Severe: sidewall instability; slope.	Severe: slope	Severe: slope; rapid permeability; sandy.	Severe: slope
Bohemian:						
BoB	Moderate: stratified substratum; moderate permeability.	Moderate: moderate permeability.	Moderate: [4] sidewall instability.	Severe: high susceptibility to frost action.	Slight	Severe: high susceptibility to frost action.
BoD	Moderate: stratified substratum; moderate permeability.	Severe: slope	Moderate: sidewall instability; slope.	Severe: high susceptibility to frost action.	Slight	Severe: high susceptibility to frost action.
Borrow pits: Bp. Too variable to be rated.						
Bowers: BrA	Severe: seasonal high water table; moderately slow permeability.	Severe: seasonal high water table.	Severe: seasonal high water table.	Moderate: moderate shrink-swell potential; high susceptibility to frost action.	Moderate: seasonal high water table.	Severe: moderate shrink-swell potential; high susceptibility to frost action.
Brevort: Bs	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Brimley: BtA	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: high susceptibility to frost action.	Moderate: seasonal high water table.	Severe: high susceptibility to frost action.
Bruce, coarse variant: Bu	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Burt: BwC	Severe: high water table: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.
*Carbondale: Cb For Lupton and Rifle parts, see Lupton and Rifle series.	Severe: high water table.	Severe: organic material; high water table.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table; organic material.
*Cathro: Ch, Ck For Tacoosh part of Ck, see Tacoosh series.	Severe: high water table.	Severe: organic material; high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table; organic material.

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [2]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Fair: seasonal high water table.	Good:[4] seasonal high water table.	Poor: sandy	Seasonal high water table; rapid seepage.	Sandy material; rapid seepage.	Seasonal high water table; rapid permeability; unstable ditchbanks.	Low available water capacity; rapid intake rate; seasonal high water table.
Good	Good: sand in substratum.	Poor: sandy	Rapid seepage	Sandy material; rapid seepage.	No drainage needed	Low available water capacity; rapid intake rate.
Good	Good: sand in substratum.	Poor: sandy	Rapid seepage	Sandy material; rapid seepage.	No drainage needed	Unfavorable topography; slopes of more than 6 percent.
Fair: slope Poor if slope is more than 25 percent.	Good: sand in substratum.	Poor: sandy	Rapid seepage	Sandy material; rapid seepage.	No drainage needed	Unfavorable topography; slopes of more than 6 percent.
Poor: high susceptibility to frost action.	Poor: some fine sand in substratum.	Fair: 10 inches of suitable material.	Moderate seepage	Unstable material; moderate seepage; piping hazard.	No drainage needed	High available water capacity; medium intake rate.
Poor: high susceptibility to frost action.	Poor: some fine sand in substratum.	Fair: slope; 10 inches of suitable material.	Moderate seepage	Unstable material; moderate seepage; piping hazard.	No drainage needed	Unfavorable topography; slopes of more than 6 percent.
Poor: moderate shrink-swell potential; high susceptibility to frost action.	Unsuitable: no sand	Fair: 11 inches of suitable material.	Seasonal high water table; slow seepage.	Fair to poor compaction characteristics; slow seepage.	Seasonal high water table; moderately slow permeability.	Seasonal high water table; moderately slow permeability.
Poor: high water table.	Poor: 20 to 40 inches of sandy material over loamy material.	Poor: poorly drained	High water table;[5] substratum has slow seepage rate.	Sandy material has rapid seepage rate; substratum has poor compaction characteristics.	High water table; upper 20 to 40 inches unstable in ditchbanks.	High water table.
Poor: high susceptibility to frost action.	Poor: some very fine sand in substratum.	Fair: 15 inches of suitable material.	Seasonal high water table; moderate seepage rate.	Unstable material; piping hazard.	Seasonal high water table; may flow when wet; unstable ditchbanks.	Seasonal high water table; moderate intake rate.
Poor: high water table.	Poor: loamy fine sand; high water table.	Poor: poorly drained	High water table; moderate seepage rate.	Unstable material; piping hazard.	High water table; ditchbanks unstable; flows when wet.	High water table.
Poor: bedrock at a depth of 10 to 20 inches.	Poor: bedrock at a depth of 10 to 20 inches.	Poor: poorly drained	Bedrock at a depth of 10 to 20 inches.	Limited volume of material; rapid seepage rate.	Bedrock at a depth of 10 to 20 inches.	High water table; bedrock at a depth of 10 to 20 inches.
Poor: high water table; organic material.	Unsuited: no sand	Poor: organic material; very poorly drained.	Organic material; rapid seepage rate.	Organic material; not suitable; rapid seepage rate.	Organic material; unstable for tile; soil subsides when drained.	High water table.
Poor: high water table; organic material.	Unsuited: no sand	Poor: organic material; very poorly drained.	12 to 51 inches of organic material; [5] substratum has moderate seepage rate.	Organic layers not suitable; substratum has fair to good compaction characteristics.	Organic material; unstable in ditchbanks; subsides when drained.	High water table.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
Charlevoix: CA	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table.
Chatham: CmA, CmB	Slight [6, 7]	Severe: moderately rapid permeability in substratum.	Severe: sidewall instability in substratum.	Slight	Severe: [5] moderately rapid permeability in substratum.	Slight
CmD	Moderate: slope	Severe: rapid permeability in substratum.	Severe: sidewall instability in substratum.	Moderate: slope	Severe: [1] rapid permeability in substratum.	Moderate: slope.
Chippeny: Cn	Severe: high water table; bedrock at a depth of 20 to 50 inches.	Severe: organic material; high water table.	Severe: high water table; bedrock at a depth of 20 to 50 inches.	Severe: high water table.	Severe: high water table.	Severe: high water table; organic material.
Croswell: CrA	Moderate: [3, 7] seasonal high water table.	Severe: rapid permeability; seasonal high water table.	Severe: sidewall instability.	Slight	Severe: rapid permeability; sandy.	Slight
*Dawson: Da, Dd For Greenwood part of Dd, see Greenwood series.	Severe: high water table.	Severe: organic material; high water table.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table; organic material.
*Deerton: DeB, DlB For Burt part of DlB, see Burt series.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.
DeD	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches; slope.
Deford: Dm	Severe: high water table.	Severe: high water table.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Duel: DuB	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.
East Lake: EaB	Slight [3]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability in substratum.	Slight

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [2]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Fair: seasonal high water table; moderate susceptibility to frost action.	Unsuited: no sand	Good: 16 inches of suitable material.	Seasonal high water table;[5] moderate seepage rate.	Fair to good compaction characteristics; good stability.	Seasonal high water table; moderate permeability.	Medium intake rate; seasonal high water table.
Good	Good [4]	Good: 23 inches of suitable material.	Rapid seepage [5] rate in substratum; will not hold water unless seal blanket is used.	Upper material has good compaction characteristics and moderate seepage rate. Substratum contains stones and has moderately rapid seepage rate.	Drainage not needed	Moderate available water capacity in upper part; medium intake rate.
Good	Fair [4]	Fair: 23 inches of suitable material; slope.	Rapid seepage [5] rate in substratum; will not hold water unless seal blanket is used.	Upper material has good compaction characteristics and moderate seepage rate. Substratum contains stones and has rapid seepage rate.	Drainage not needed	Unfavorable topography; slopes of more than 6 percent.
Poor: organic material; high water table.	Unsuited: no sand	Poor: organic material; very poorly drained.	Organic material; bedrock at a depth of 20 to 50 inches.	Organic material over bedrock; not suitable.	Organic material; unstable ditchbanks; bedrock at a depth of 20 to 51 inches.	High water table.
Good	Good: seasonal high water table.	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Sandy material; rapid seepage rate; piping hazard.	Drainage not needed	Very low available water capacity; rapid water intake rate.
Poor: organic material; high water table.	Poor: 12 to 51 inches of organic material over sand.	Poor: organic material; very poorly drained.	Organic material and sandy material have rapid seepage rate.	Organic material ove sand; not suitable.	Generally not drained, because of high acidity; organic material and sand unstable in ditches.	High water table.
Fair: bedrock at a depth of 20 to 40 inches.	Poor: bedrock at a depth of 20 to 40 inches.	Poor: sandy	Bedrock at a depth of 20 to 40 inches; rapid seepage rate.	Limited amount of material; sandy; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Fair: bedrock at a depth of 20 to 40 inches.	Poor: bedrock at a depth of 20 to 40 inches.	Poor: sandy	Bedrock at a depth of 20 to 40 inches; rapid seepage rate.	Limited amount of material; sandy; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Poor: high water table	Poor: loamy fine sand.	Poor: poorly drained	High water table; rapid seepage rate.	Unstable fine sand; subject to piping.	High water table; unstable in ditchbanks; flows when wet.	High water table.
Fair: bedrock at a depth of 20 to 40 inches.	Poor: bedrock at a depth of 20 to 40 inches.	Poor: sandy	Bedrock at a depth of 20 to 40 inches; rapid seepage rate.	Limited amount of material; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Good	Fair [4]	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Sandy material; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
East Lake, acid variant: EcB	Slight [3,5]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: very rapid permeability in substratum.	Slight
EcD	Moderate: [3] slope	Severe: rapid permeability.	Severe: sidewall instability.	Moderate: slope.	Severe: very rapid permeability in substratum.	Moderate: slope
*Eastport: EdB, EeB For Roscommon part of EeB, see Roscommon series.	Slight [3,5]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability.	Slight
Emmet: EmA, EmB	Slight: [5,6] moderate permeability.	Moderate: moderate permeability. Severe where slopes are more than 2 percent.	Slight	Slight	Slight [5]	Slight
EmC	Moderate: slope; moderate permeability.	Severe: slope	Moderate: slope	Moderate: slope	Slight [5]	Moderate: slope
Ensign: EnA	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.
*Ensley: Es For Angelica part, see Angelica series.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Fairport: FaA, FaB	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches; moderate shrink-swell potential.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches; moderate shrink-swell potential.
Gilchrist: GcB	Slight [6]	Moderate: moderate permeability in substratum. Severe where slopes are more than 3 percent.	Moderate: sidewall instability in upper 20 to 40 inches.	Slight	Slight: 20 to 40 inches of sandy material over loamy material.	Slight
Grayling: GrB	Slight [3]	Severe: very rapid permeability.	Severe: sidewall instability.	Slight	Severe: very rapid permeability.	Slight
GrD	Moderate: [3] slope	Severe: very rapid permeability.	Severe: sidewall instability.	Moderate: slope	Severe: very rapid permeability.	Moderate: slope
Greenwood: Gw	Severe: high water table.	Severe: organic material; high water table.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table; organic material.

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [2]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Good	Fair [4]	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Sandy material; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Good	Fair [4]	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Sandy material; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Good	Good	Poor: sandy	Rapid seepage rate; [5] will not hold water unless seal blanket is used.	Sandy material; rapid seepage rate.	Drainage not needed	Very low available water capacity; rapid intake rate.
Good	Unsuited: no sand	Good: 18 inches of suitable material.	Moderate [5] seepage rate.	Good compaction characteristics; moderate seepage rate.	Drainage not needed	Moderate available water capacity; medium intake rate.
Good	Unsuited: no sand	Fair: 18 inches of suitable material; slope.	Moderate [5] seepage rate.	Good compaction characteristics; moderate seepage rate.	Drainage not needed	Unfavorable topography; slopes of more than 6 percent.
Poor: bedrock at a depth of 10 to 20 inches.	Unsuited: no sand	Fair: 9 inches of suitable material.	Bedrock at a depth of 10 to 20 inches; fractures allow seepage.	Not suitable: less than 20 inches of material.	Bedrock at a depth of 10 to 20 inches.	Bedrock at a depth of 10 to 20 inches; not used for irrigated crops.
Poor: high water table.	Unsuited: no sand	Poor: poorly drained.	High water [5] table; moderate seepage rate.	Fair to good compaction characteristics; moderate seepage rate.	High water table; moderate permeability.	High water table.
Poor: bedrock at a depth of 20 to 40 inches; high susceptibility to frost action.	Unsuited: no sand	Fair: 9 inches of suitable material.	Bedrock at a depth of 20 to 40 inches; fractured bedrock allows seepage.	Fair to good compaction characteristics; low seepage rate.	Drainage not needed	Moderate intake rate moderately slow permeability.
Good	Poor: 20 to 40 inches of sandy material over loamy material.	Poor: sandy	Rapid seepage rate in upper part; moderate seepage rate in substratum.	Fair to good compaction characteristics; underlying material has good stability.	Drainage not needed.	Low available water capacity; rapid intake rate.
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Sandy material; rapid seepage rate; piping hazard.	Drainage not needed	Very low available water capacity; rapid intake rate.
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Sandy material; rapid seepage rate; piping hazard.	Drainage not needed	Very low available water capacity; rapid intake rate.
Poor: organic material; high water table.	Unsuited: no sand	Poor: organic material; very poorly drained.	Organic material; rapid seepage rate.	Organic material; not suitable.	Generally not drained, because of high acidity.	High water table.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
Iosco: IoB	Severe: seasonal high water table.	Severe: seasonal high water table; rapid permeability in upper part of subsoil.	Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table.
Kalkaska:						
KaB	Slight [3,5]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability in substratum.	Slight
KaD	Moderate: [3] slope	Severe: rapid permeability.	Severe: sidewall instability.	Moderate: slope	Severe: rapid permeability in substratum.	Moderate: slope.
KaE	Severe: slope	Severe: rapid permeability.	Severe: sidewall instability; slope.	Severe: slope	Severe: rapid permeability in substratum.	Severe: slope
Karlin:						
KdB	Slight [3]	Severe: rapid permeability in substratum.	Severe: sidewall instability in substratum.	Slight	Severe: rapid permeability in substratum.	Slight
KdD	Moderate: [5] slope	Severe: rapid permeability in substratum.	Severe: sidewall instability in substratum.	Moderate: slope	Severe: rapid permeability in substratum.	Moderate: slope.
Kawbawgam: KgC	Severe: seasonal high water table; bedrock at a depth of 20 to 40 inches.	Severe: seasonal high water table; bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: seasonal high water table; bedrock at a depth of 20 to 40 inches.
Kawkawlin: KlA	Severe: seasonal high water table; moderately slow permeability.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: moderate shrink-swell potential; high susceptibility to frost action.	Moderate: [5] difficult to work.	Moderate: seasonal high water table; moderate shrink-swell potential.
Keweenaw:						
KnB	Slight	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability.	Slight
KnD	Moderate: slopes	Severe: rapid permeability.	Severe: sidewall instability.	Moderate: slope	Severe: rapid permeability.	Moderate: slope
Kinross: Kr	Severe: high water table.	Severe: high water table; very rapid permeability.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Kiva:						
KsB	Slight [3,5]	Severe: very rapid permeability in substratum.	Severe: sidewall instability.	Slight	Severe: very rapid permeability in substratum.	Slight
KsD	Moderate: [3] slope	Severe: very rapid permeability in substratum.	Severe: sidewall instability.	Moderate: slope	Severe: very rapid permeability in substratum.	Moderate: slope

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [3]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Fair in upper 20 to 40 inches; substratum is moderately susceptible to frost action.	Poor: loamy material at a depth of 20 to 40 inches.	Poor: sandy	Rapid seepage rate in upper part, and slow seepage rate in substratum.	Upper material sandy; rapid seepage rate; substratum has fair compaction characteristics and stability.	Seasonal high water table; sandy material unstable when wet.	Seasonal high water table; low available water capacity in upper part; rapid intake rate.
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Poor to fair stability; rapid seepage rate.	Drainage not needed	Very low available water capacity; rapid intake rate.
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Poor to fair stability; rapid seepage rate.	Drainage not needed	Very low available water capacity; rapid intake rate.
Generally fair: slope. Poor where slopes are more than 25 percent.	Good	Poor: sandy	Rapid seegape rate; will not hold water unless seal blanket is used.	Poor to fair stability; rapid seepage rate.	Drainage not needed	Very low available water capacity; rapid intake rate.
Good	Good: sand in substratum.	Good: 17 inches of suitable material.	Rapid seepage rate in substratum; will not hold water unless seal blanket is used.	Fair to good compaction characteristics and stability in upper part; substratum has rapid seepage rate.	Drainage not needed	Moderate available water capacity in upper part; medium intake rate.
Good	Good: sand in substratum.	Fair: 17 inches of suitable material; slope.	Rapid seepage rate in substratum; will not hold water unless seal blanket is used.	Fair to good compaction characteristics and stability in upper part; substratum has rapid seepage rate.	Drainage not needed	Unfavorable topography; slopes are more than 6 percent.
Fair: seasonal high water table; bedrock at a depth of 20 to 40 inches.	Unsuited: no sand	Good: 18 inches of suitable material.	Bedrock at a depth of 20 to 40 inches.	Limited amount of material; soil material has good compaction characteristics; moderate seepage rate.	Bedrock at a depth of 20 to 40 inches; moderate permeability.	Seasonal high water table; medium intake rate.
Poor: seasonal high water table; high susceptibility to frost action.	Unsuited: no sand	Fair: 10 inches of suitable material.	Seasonal [5] high water table; slow seepage rate.	Fair to good stability; low seepage rate.	Seasonal high water table; moderately slow permeability.	Seasonal high water table; medium intake rate; moderately slow permeability.
Good	Poor: loamy sand	Poor: sandy	Rapid seepage rate	Fair to good stability; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Good	Poor: loamy sand	Poor: sandy	Rapid seepage rate	Fair to good stability; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Poor: high water table.	Good: high water table.	Poor: poorly drained	High water table; rapid seepage rate.	Poor stability; rapid seepage rate.	High water table; material flows when wet; ditchbanks unstable.	High water table.
Good	Fair [4]	Fair: 12 inches of suitable material.	Rapid seepage rate in substratum; gravelly material.	Fair compaction characteristics; rapid seepage rate.	Drainage not needed	Medium intake rate; moderate available water capacity in upper part.
Good	Fair [4]	Fair: 12 inches of suitable material; slope.	Rapid seepage rate in substratum; gravelly material.	Fair compaction characteristics; rapid seepage rate.	Drainage not needed	Unfavorable topography; slopes are more than 6 percent.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
Lake beaches: Lb. Severe limitations for most uses.						
Limestone rock land: Lm. Severe limitations for most uses.						
Longrie:						
LoA, LoB	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.
LsD. For Summerville part, see Summerville soils.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.
Lupton. Mapped only with Carbondale and Rifle soils.	Severe: high water table.	Severe: organic material; high water table.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Made land: Ma. Too variable to be rated.						
Mancelona:						
McB	Slight [3]	Severe: rapid permeability in substratum.	Severe: sidewall instability.	Slight	Severe: rapid permeability in substratum.	Slight
McD	Moderate: slope	Severe: rapid permeability in substratum.	Severe: sidewall instability.	Moderate: slope	Severe: rapid permeability in substratum.	Moderate: slope
Marsh: Mh. Severe limitations for most uses.						
Melita: MlB	Slight [6]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability.	Slight
Menominee:						
MnB	Moderate: moderately slow permeability in substratum.	Moderate: 20 to 40 inches of sand over moderately slowly permeable material.	Moderate: sidewall instability in upper 20 to 40 inches.	Slight	Slight: 20 to 40 inches of sandy material over loam.	Slight
MnD	Moderate: moderately slow permeability in substratum; slope.	Severe: slope	Moderate: sidewall instability in upper 20 to 40 inches.	Moderate: slope	Slight: 20 to 40 inches of sandy material over loam.	Moderate: slope

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [2]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Fair: moderate susceptibility to frost action; bedrock at a depth of 20 to 40 inches.	Unsuited: no sand	Fair: 12 inches of suitable material; bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches allows seepage; moderate seepage rate in soil material.	Limited volume of material; good compaction characteristics and stability; moderate seepage in soil material.	Drainage not needed	Moderate available water capacity; medium water intake rate.
Fair: moderate susceptibility to frost action; bedrock at a depth of 20 to 40 inches.	Unsuited: no sand	Fair: 12 inches of suitable material; bedrock at a depth of 20 to 40 inches; slope.	Bedrock at a depth of 20 to 40 inches allows seepage; moderate seepage rate in soil material.	Limited volume of material; good compaction characteristics and stability; moderate seepage in soil material.	Drainage not needed	Unfavorable topography; slopes are more than 6 percent.
Poor: organic material; high water table.	Unsuited: no sand	Poor: organic material; very poorly drained.	Organic material; rapid seepage rate.	Organic material; not suitable.	Organic material; unstable in ditch banks; subsides when drained.	High water table.
Good	Good [4]	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Fair stability; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid water intake rate.
Good	Fair [4]	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Fair stability; rapid seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Good	Fair: loamy material below a depth of 40 to 66 inches.	Poor: sandy	Upper 40 inches has rapid seepage rate and will not hold water unless seal blanket is used; slow seepage rate at a depth of 40 to 60 inches.	Upper 40 to 60 inches has poor stability and rapid seepage rate; substratum is suitable.	Drainage not needed	Very low available water capacity; rapid intake rate.
Fair: substratum highly susceptible to frost action.	Fair: loamy material at a depth of 20 to 40 inches.	Poor: sandy	Rapid seepage rate in upper part; slow seepage rate in substratum.	Upper 20 to 40 inches has poor stability and rapid seepage rate; substratum has good stability and slow seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.
Fair: substratum highly susceptible to frost action.	Fair: loamy material at a depth of 20 to 40 inches.	Poor: sandy	Rapid seepage rate in upper part; slow seepage rate in substratum.	Upper 20 to 40 inches has poor stability and rapid seepage rate; substratum has good stability and slow seepage rate.	Drainage not needed	Low available water capacity; rapid intake rate.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
Munising:						
MuB	Severe: moderately slow permeability in fragipan.	Moderate: moderate permeability except in fragipan.	Moderate: strong fragipan.	Slight	Slight [5]	Slight
MuD	Severe: moderately slow permeability in fragipan; slope.	Severe: slope	Moderate: slope; strong fragipan.	Moderate: slope	Slight	Moderate: slope
MuE	Severe: moderately slow permeability in fragipan; slope.	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope
Nahma: Nh	Severe: high water table.	Severe: high water table; bedrock at a depth of 20 to 40 inches.	Severe: high water table; bedrock at a depth of 20 to 40 inches.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Nester: NsA, NsB	Severe: moderately slow permeability.	Slight: moderate where slopes are more than 2 percent.	Slight	Severe: *moderate to* high shrink-swell potential; high susceptibility to frost action.	Moderate: difficult to work.	Severe: moderate to high shrink-swell potential; high susceptibility to frost action.
Onaway:						
OnA, OnB	Severe: [5] moderately slow permeability in subsoil.	Moderate: moderate permeability above and *below fragipan.*	Slight [5, 7]	Severe: high susceptibility to frost action.	Slight [5, 7]	Severe: high susceptibility to frost action.
OnC	Severe: slope; moderately slow permeability in subsoil.	Severe: slope	Moderate: slope	Severe: high susceptibility to frost action.	Slight [5]	Severe: high susceptibility to frost action.
OnD	Severe: slope; moderately slow permeability in subsoil.	Severe: slope	Moderate: slope	Severe: high susceptibility to frost action.	Moderate: slope	Severe: high susceptibility to frost action.
*Onota:						
OoE For Chippeny part, see Chippeny series.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches; slope.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: slope	Severe: bedrock at a depth of 20 to 40 inches; slope.	Severe: slope
OrB For Deerton part, see Deerton series.	Severe: bedrock at a depth or 20 to 40 inches.	Severe: bedrock at a a depth of 20 to 40 inches.	Severe: bedrock at a a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.
OrD For Deerton part, see Deerton series.	Severe: bedrock at a depth of 20 to 40 inches; slope.	Severe: bedrock at a depth of 20 to 40 inches; slope.	Severe: bedrock at a depth of 20 to 40 inches; slope.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches; slope.
Otisco: OtB	Severe: seasonal high water table; rapid permeability.	Severe: seasonal high water table; rapid permeability.	Severe: seasonal high water table; sidewall instability.	Moderate: seasonal high water table.	Severe: rapid permeability; seasonal high water table.	Moderate: seasonal high water table.
Pickford: Pc	Severe: high water table; very slow permeability.	Severe: high water table.	Severe: high water table; poor workability.	Severe: high water table; high shrink-swell potential.	Severe: high water table; poor workability.	Severe: high water table; high shrink-swell potential.

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [2]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Fair: moderate susceptibility to frost action.	Unsuited: no sand	Fair: 13 inches of suitable material.	Moderate [5] seepage rate.	Good compaction characteristics; moderate seepage rate.	Drainage not needed; temporarily saturated above fragipan in places.	Moderate available water capacity; medium intake rate; fragipan has moderately slow permeability.
Fair: moderate susceptibility to frost action.	Unsuited: no sand	Fair: 13 inches of suitable material; slope.	Moderate seepage rate.	Good compaction characteristics; moderate seepage rate.	Drainage not needed; temporarily saturated above fragipan in places.	Unfavorable topography; slopes are more than 6 percent.
Poor: moderate susceptibility to frost action; slope.	Unsuited: no sand	Poor: slope	Moderate seepage rate	Good compaction characteristics; moderate seepage rate.	Drainage not needed; temporarily saturated above fragipan in places.	Unfavorable topography; slopes are more than 6 percent.
Poor: high water table	Unsuited: no sand	Poor: poorly drained	High water table; bedrock at a depth of 20 to 40 inches; moderate seepage rate.	Limited amount of material; moderate seepage rate.	High water table; bedrock at a depth of 20 to 40 inches.	High water table.
Poor: moderate to high shrink-swell potential; high susceptibility to frost action.	Unsuited: no sand	Fair: 9 inches of suitable material.	Slow seepage rate [5]	Fair to good compaction characteristics; good stability; slow seepage rate.	Drainage not needed	High available water capacity; medium intake rate; moderately slow permeability.
Poor: high susceptibility to frost action.	Unsuited: no sand	Fair: 10 inches of suitable material.	Moderate to slow seepage rate. [5]	Poor compaction characteristics; moderate to slow seepage rate.	Drainage not needed	High available water capacity; medium intake rate.
Poor: high susceptibility to frost action.	Unsuited: no sand	Fair: 10 inches of suitable material.	Moderate to slow seepage rate. [5]	Poor compaction characteristics; moderate to slow seepage rate.	Drainage not needed	Unfavorable topography; slopes are more than 6 percent.
Poor: high susceptibility to frost action.	Unsuited: no sand	Fair: 10 inches of suitable material; slope.	Moderate to slow seepage rate.	Poor compaction characteristics; moderate to slow seepage rate.	Drainage not needed	Unfavorable topography; slopes are more than 6 percent.
Poor: slope	Unsuited: no sand	Poor: slope	Steep: bedrock at a depth of 20 to 40 inches.	Steep: limited amount of material.	Drainage not needed	Unfavorable topography; steep.
Fair: bedrock at a depth of 20 to 40 inches.	Unsuited: no sand	Fair: 10 inches of suitable material; bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches; moderate seepage rate in soil material.	Limited amount of material; moderate seepage rate; good compaction characteristics.	Generally not needed	Moderate available water capacity; medium intake rate.
Fair: bedrock at a depth of 20 to 40 inches.	Unsuited: no sand	Fair: 10 inches of suitable material; bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches; moderate seepage rate in soil material.	Limited amount of material; moderate seepage rate; good compaction characteristics.	Generally not needed	Unfavorable topography; slopes are more than 6 percent.
Fair: seasonal high water table.	Fair: sand and loamy sand.	Poor: sandy	Seasonal high water table; rapid seepage rate.	Fair to poor stability; rapid seepage rate.	Seasonal high water table; unstable in ditchbanks; flows when wet.	Seasonal high water table; low available water capacity.
Poor: high water table; high shrink-swell potential.	Unsuited: no sand	Poor: poorly drained	High water table; slow seepage rate.	Fair to poor compaction characteristics; clayey; difficult to work; slow seepage rate.	High water table; very slow permeability.	High water table.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
*Pickford, moderately wet: PfA, PkA. For Pickford part of PkA, see Pickford series.	Severe: seasonal high water table; very slow permeability.	Severe: seasonal high water table.	Severe: seasonal high water table; poor workability.	Severe: high shrink-swell potential.	Severe: seasonal high water table; poor workability.	Severe: high shrink-swell potential.
Rifle. Mapped only with Carbondale and Lupton soils.	Severe: high water table.	Severe: organic material; high water table.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table; organic material.
*Roscommon: Rc, RkB. For Kalkaska part of RkB, see Kalkaska series.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Rousseau:						
RoB	Slight [3, 6]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability.	Slight
RoD	Moderate: [3] slope	Severe: rapid permeability.	Severe: sidewall instability.	Moderate: slope	Severe: rapid permeability.	Moderate: slope
RsD	Slight [3] where slope is 0 to 6 percent. Moderate where slope is 6 to 18 percent. Severe where slope is more than 18 percent.	Severe: rapid permeability.	Severe: sidewall instability.	Moderate to severe: slope.	Severe: rapid permeability.	Severe: slope
Rubicon:						
RuB	Slight [3]	Severe: very rapid permeability.	Severe: sidewall instability.	Slight	Severe: very rapid permeability.	Slight
RuD	Moderate: [3] slope	Severe: very rapid permeability.	Severe: sidewall instability.	Moderate: slope	Severe: very rapid permeability.	Moderate: slope
RuE	Severe: slope	Severe: very rapid permeability.	Severe: sidewall instability.	Severe: slope	Severe: very rapid permeability.	Severe: slope
Ruse: Rv	Severe: high water table; bedrock at a depth of 10 to 20 inches.	Severe: high water table; bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.
Saugatuck: ScA	Severe: high water table; cemented subsoil.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Shelldrake: ShB	Slight [3, 7]	Severe: very rapid permeability.	Severe: sidewall instability.	Slight	Severe: very rapid permeability.	Slight

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [2]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Poor: seasonal high water table; high shrink-swell potential.	Unsuited: no sand	Poor: less than 8 inches of suitable material.	Seasonal high water table; slow seepage rate.	Fair to poor compaction characteristics; clayey; difficult to work; slow seepage rate.	Seasonal high water table; very slow permeability.	Seasonal high water table; very slow permeability.
Poor: high water table; organic material.	Unsuited: no sand	Poor: organic material; very poorly drained.	Organic material; rapid seepage rate.	Organic material; not suitable.	High water table; organic material unstable in ditch banks; subsides when drained.	High water table.
Poor: high water table.	Good: high water table.	Poor: poorly drained	High water table; [5] rapid seepage rate.	Rapid seepage rate; poor stability.	High water table; unstable in ditch banks; flows when wet.	High water table.
Good	Fair: fine sand	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Rapid seepage rate; poor stability; piping hazard.	Drainage not needed; rapid water intake rate.	Low available water capacity; rapid water intake rate.
Good	Fair: fine sand	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Rapid seepage rate; poor stability; piping hazard.	Drainage not needed; rapid water intake rate.	Low available water capacity; rapid water intake rate.
Good where slope is less than 18 percent. Fair where slopes are more than 18 percent.	Fair: fine sand	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Rapid seepage rate; poor stability; piping hazard.	Drainage not needed; rapid water intake rate.	Low available water capacity; rapid intake rate.
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Rapid seepage rate; poor stability.	Drainage not needed	Very low available water capacity; rapid intake rate.
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Rapid seepage rate; poor stability.	Drainage not needed	Very low available water capacity; rapid intake rate.
Fair where slope is less than 25 percent. Poor where slope is more than 25 percent.	Good: steep slopes	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Rapid seepage rate; poor stability.	Drainage not needed	Very low available water capacity; rapid intake rate.
Poor: bedrock at a depth of 10 to 20 inches; high water table.	Unsuited: no sand	Poor: poorly drained; bedrock at a depth of 10 to 20 inches.	Bedrock at a depth of 10 to 20 inches; bedrock allows seepage.	Not suitable; less than 20 inches of material.	Bedrock at a depth of 10 to 20 inches.	Bedrock at a depth of 10 to 20 inches.
Poor: high water table.	Good: high water table.	Poor: poorly drained	High water table; rapid seepage rate.	Rapid seepage rate; poor stability.	High water table; unstable in ditch banks; flows when wet; cemented subsoil.	High water table.
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Rapid seepage rate; poor stability.	Drainage not needed	Very low available water capacity; rapid intake rate.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
Skanee: SkB	Severe: seasonal high water table; fragipan.	Severe: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table.
Steuben:						
StB	Severe: moderately slow permeability in fragipan.	Severe: rapid permeability in substratum.	Severe: sidewall instability in substratum.	Slight	Severe: rapid permeability in substratum.	Slight
StD	Severe: moderately slow permeability in fragipan; slope.	Severe: rapid permeability in substratum.	Severe: sidewall instability in substratum.	Moderate: slope	Severe: rapid permeability in substratum.	Moderate: slope
Summerville: SuA	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.
Sundell: SvA	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: high susceptibility to frost action; bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: high susceptibility to frost action; bedrock at a depth of 20 to 40 inches.
Sundell, sandy variant: SwA	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: seasonal high water table; bedrock at a depth of 20 to 40 inches.
Tacoosh. Mapped only with Cathro soils.	Severe: high water table.	Severe: organic material; high water table.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table; organic material.
Tawas: Ta	Severe: high water table.	Severe: organic material; high water table.	Severe: high water table; sidewall instability.	Severe: high water table.	Severe: high water table.	Severe: high water table; organic material.
Trenary:						
TrA, TrB	Severe: [5] moderately slow permeability in subsoil.	Moderate: moderate permeability above fragipan.	Slight [5, 7]	Slight	Slight [5]	Moderate: moderate susceptibility to frost action.
TrC	Severe: slope; moderately slow permeability in subsoil.	Severe: slope	Moderate: slope	Moderate: slope	Slight [5]	Moderate: moderate susceptibility to frost action.
TrD	Severe: slope; moderately slow permeability in subsoil.	Severe: slope	Moderate: slope	Severe: slope	Slight [5]	Severe: slope
Wainola: WaA	Severe: seasonal high water table.	Severe: seasonal high water table; rapid permeability.	Severe: seasonal high water table; sidewall instability.	Moderate: seasonal high water table.	Severe: seasonal high water table; rapid permeability.	Moderate: seasonal high water table.

See footnotes at end of table.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [3]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Fair: seasonal high water table; moderate susceptibility to frost action.	Unsuited: no sand.	Fair: 14 inches of suitable material.	Seasonal high water table; [5] fragipan at a depth of 13 inches; moderate seepage rate.	Good compaction characteristics; moderate seepage rate.	Seasonal high water table; fragipan.	Seasonal high water table; medium intake rate.
Good	Good: sand in substratum.	Good: 19 inches of suitable material.	Rapid seepage rate in substratum.	Upper part has good compaction characteristics; substratum has poor compaction characteristics and rapid seepage rate.	Drainage not needed.	Moderate available water capacity in upper part; moderate intake rate.
Good	Good: sand in substratum.	Fair: 19 inches of suitable material; slope.	Rapid seepage rate in substratum.	Upper part has good compaction characteristics; substratum has poor compaction characteristics and rapid seepage rate.	Drainage not needed.	Unfavorable topography; slopes are more than 6 percent.
Poor: bedrock at a depth of 10 to 20 inches.	Unsuited: no sand.	Poor: bedrock at a depth of 10 to 20 inches.	Bedrock at a depth of 10 to 20 inches; bedrock allows seepage.	Not suitable: less than 20 inches of material.	Drainage not needed.	Bedrock at a depth of 10 to 20 inches.
Poor: bedrock at a depth of 20 to 40 inches; high susceptibility to frost action.	Unsuited: no sand.	Fair: 17 inches of suitable material; bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches; soil material has moderate seepage rate.	Limited amount of material; moderate seepage rate.	Bedrock at a depth of 20 to 40 inches.	Seasonal high water table; medium intake rate.
Fair: seasonal high water table; bedrock at a depth of 20 to 40 inches.	Poor: loamy fine sand; bedrock at a depth of 20 to 40 inches.	Poor: sandy.	Bedrock at a depth of 20 to 40 inches; sandy material has rapid seepage rate.	Limited amount of material; rapid seepage rate.	Bedrock at a depth of 20 to 40 inches.	Seasonal high water table; rapid intake rate.
Poor: organic material; high water table.	Unsuited: no sand.	Poor: organic material; very poorly drained.	High water table; [5] rapid seepage rate in organic material; moderate seepage rate in substratum.	Organic material unsuitable; substratum has good stability.	High water table; organic material unstable in ditch banks; moderate permeability in loamy material.	High water table.
Poor: organic material; high water table.	Poor: 12 to 51 inches of organic material over sand.	Poor: organic material; very poorly drained.	High water table; rapid seepage rate.	Organic material unsuitable; substratum has rapid seepage rate and is unstable.	High water table; organic material and sandy material unstable in ditch banks; sandy material flows when wet.	High water table.
Fair: moderate susceptibility to frost action.	Unsuited: no sand.	Good: 17 inches of suitable material.	Moderate seepage rate [5].	Good compaction characteristics; moderate seepage rate.	Drainage not needed.	Moderate available water capacity; medium water intake rate.
Fair: moderate susceptibility to frost action.	Unsuited: no sand.	Fair: 17 inches of suitable material; slope.	Moderate seepage rate.	Good compaction characteristics; moderate seepage rate.	Drainage not needed.	Unfavorable topography; slopes are more than 6 percent.
Fair: moderate susceptibility to frost action.	Unsuited: no sand.	Fair: 17 inches of suitable material; slope.	Moderate seepage rate.	Good compaction characteristics; moderate seepage rate.	Drainage not needed.	Unfavorable topography; slopes are more than 6 percent.
Fair: seasonal high water table.	Fair: fine sand.	Poor: sandy.	Seasonal high water table; rapid seepage rate.	Poor stability; rapid seepage rate; piping hazard.	Seasonal high water table; unstable in ditch banks; flows when wet.	Seasonal high water table; rapid intake rate.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills [1] (trench type)	Local roads and streets
Wallace:						
WlB	Slight or moderate: [3,7] variable cementation in subsoil.	Severe: very rapid permeability in substratum.	Severe: sidewall instability.	Slight	Severe: very rapid permeability in substratum.	Slight
WlD	Moderate: [3] variable cementation in subsoil; slope.	Severe: very rapid permeability in substratum; slope.	Severe: sidewall instability.	Moderate: slope	Severe: very rapid permeability in substratum.	Moderate: slope
Wheatley: Wm	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Severe: high water table.
Yalmer:						
YaB	Severe: [7] moderately slow permeability in fragipan.	Moderate: rapid permeability above a depth of 24 inches.	Moderate: strong fragipan.	Slight	Slight	Slight
YaD	Severe: moderately slow permeability in fragipan; slope.	Severe: slope	Moderate: strong fragipan.	Moderate: slope	Slight	Moderate: slope

[1] Onsite deep studies of the underlying strata, water table, and hazard of aquifer pollution and drainage into ground water need to be made for landfills deeper than 5 or 6 feet.

[2] Includes upper part of subsoil where subsoil is suitable.

[3] Pollution is a hazard in places because of rapid to very rapid permeability in the substratum.

[4] These soils contain gravel.

that have low strength when wet and they are the poorest soils for subgrade.

Soil properties significant to engineering

In table 5, the soil series and the symbol for each mapping unit are listed and estimates of properties significant to engineering are given. The estimated properties are those of the representative soil. Where test data are available, that information was used. Where tests were not performed, the estimates shown are based on comparisons of the soils in the survey area with similar soils tested in other counties. Following are explanations of some of the columns in table 5.

Soil hydrologic group is a rating of soils to give an estimate of direct runoff from rainfall. Soil properties are considered that influence the minimum rate of infiltration obtained for a bare soil after prolonged wetting. These properties are depth of the seasonal high water table, intake rate, and permeability after prolonged wetting. The soils are rated at four levels: A, low runoff potential; B, moderately low runoff potential; C, moderately high runoff potential; and D, high runoff potential. Because of the factor of artificial drainage, some soils have several possible ratings, depending on the degree of actual drainage.

Depth to bedrock is measured in inches from the surface and is the range in which bedrock is encountered in most areas of a particular soil. Some of the soils that have depth to bedrock shown as 60 inches or more may have inclusions of bedrock between depths of 40 and 60 inches in a given mapping unit. This inclusion is indicated in table 5 by footnotes. Bedrock is considered to be the solid or fractured rock that generally underlies the soil.

Depth to the seasonal high water table is the maximum height to which the water table rises during the year. The estimates are for soil material that has not been artificially drained. In general, the information in the table applies to a depth of 5 feet or less. During prolonged wet or extremely dry periods, the depth commonly is outside the range shown in table 5. Depth from the surface normally is given only for the major horizons of the representative soils for the series. Other horizons are listed if they have engineering properties significantly different from adjacent horizons.

The estimated classification according to the textural classification of the U.S. Department of Agriculture and according to the AASHTO and Unified classification systems is given for each important layer. The figures showing the percentages of material passing through sieves Nos. 4, 10, and 200 are rounded off to the nearest 5 percent. The percentage passing the No. 200 sieve approximates the combined amount of silt and clay in the soil. The percentage of coarse fragments larger than 3 inches in diameter is given in table 5 footnotes.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand	Topsoil [2]	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Poor stability; rapid seepage rate.	Drainage not needed	Very low available water capacity; rapid intake rate.
Good	Good	Poor: sandy	Rapid seepage rate; will not hold water unless seal blanket is used.	Poor stability; rapid seepage rate.	Drainage not needed	Very low available water capacity; rapid intake rate.
Poor: high water table	Fair: [4] high water table.	Poor: poorly drained	High water table; rapid seepage rate.	Poor stability; rapid seepage rate.	High water table; material unstable in ditch banks; flows when wet.	High water table.
Good	Poor: loamy material at a depth of 20 to 40 inches.	Poor: sandy	Rapid seepage rate in upper part; moderate seepage rate in substratum.	Upper material has poor stability and rapid seepage rate; substratum has good stability and moderate seepage rate.	Drainage not needed	Low available water capacity in upper part; rapid intake rate.
Good	Poor: loamy material at a depth of 20 to 40 inches.	Poor: sandy	Rapid seepage rate in upper part; moderate seepage rate in substratum.	Upper material has poor stability and rapid seepage rate; substratum has good stability and moderate seepage rate.	Drainage not needed	Low available water capacity in upper part; rapid intake rate.

[5] In places bedrock is at a depth of 40 to 60 inches in a given mapping unit delineation.

[6] Some of the lower areas of these soils are moderately well drained and have a seasonal high water table between depths of 3 and 4 feet.

[7] Some of the lower areas of these soils are moderately well drained and have a seasonal high water table between a depth of 2 and 3 feet.

In the column showing permeability are estimates of the rate at which water moves downward through undisturbed soil material. The estimates are based mainly on texture, structure, and consistence of the soils.

Available water capacity refers to the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Reaction, as shown in table 5, is the measured range in pH values for each major horizon of the described representative soils as determined in the field. It indicates the acidity or alkalinity of the soils. A pH of 7.0, for example, indicates a neutral soil; a lower pH indicates acidity; and a higher value indicates alkalinity.

Shrink-swell potential refers to the change in volume of the soil that results from a change in moisture content. The estimates are based mainly on the amount and kind of clay in the soil.

The soils are also rated in table 5 according to the degree that they encourage the corrosion of conduits laid in them. Ratings are given for uncoated steel conduits and concrete conduits. The texture and natural drainage of a soil affect this potential through their influence on aeration, content of water, and movement of water. The pH of the soil also may be important.

Engineering interpretations of the soils

Engineering interpretations are given in table 6. The data in this table apply to the representative profile described for the soil series in the section "Descriptions of the Soils."

Limitations of the soils for use as septic tank absorption fields and soil features that affect their use for this purpose are shown in table 6. Some of the limiting factors are permeability, depth to water table, depth to bedrock, flooding hazard, and relief. Soils that have somewhat poor drainage or poor drainage, a seasonal high water table, or slow permeability are poor sites. A sewage disposal system does not function properly in such soils. A percolation rate of 45 minutes per inch or less is desirable for a septic tank absorption field. This is equivalent to a permeability rate of 1.25 inches per hour. Permeability rates for the soils are given in table 5.

The factors considered in determining the limitations of the soils for sewage lagoons are permeability, slope, depth to bedrock, depth to seasonal high water table, and organic matter content. These factors are mainly for the lagoon floor. The requirements for the dams or embankments are the same as for those considered in the column "Embankments, dikes, and levees."

Features considered in determining limitations for shallow excavations, those that require trenching or excavating to a depth of 5 or 6 feet or less, are depth to

water table, slope, texture of material to be excavated, and depth to bedrock.

The soils are also rated in table 6 as to their limitations for buildings that are no more than three stories high and that do not have basements. The limitations of the soils as a base for low buildings depend mainly on characteristics of the substratum, which generally provides the base for foundations. Ratings are therefore for the substratum. Important factors considered in determining the limitations of the soils as foundations for low buildings are susceptibility to frost heaving, slope, depth to water table, depth to bedrock, and shrink-swell potential. Engineers and others should not apply specific values to the estimates given.

In determining limitations of the soils for trench-type sanitary landfill, consideration is given to texture, permeability, depth to seasonal high water table, and depth to bedrock.

The entire soil profile was considered to determine the limitations of the soils for local roads and streets. The features shown in table 6 are for undisturbed soils without artificial drainage. Slope, depth to water table, susceptibility to frost action, shrink-swell potential, and depth to bedrock are some of the soil features considered. Additional information can be obtained from data compiled by the State Highway Department of Michigan, which has rated the major soil series in the State for their suitability for highway construction. This information is in the "Field Manual of Soil Engineering" (*2*).

Ratings of the suitability of the soils as a source of roadfill are based on performance of soil material used as borrow for subgrade. Both the subsoil and substratum are rated if they have contrasting characteristics. The most suitable material is sand with enough fines for binding; the least suitable is clay.

Ratings of suitability of the soils as a source of sand apply only to material within a depth of 5 feet. Some soils that are rated "unsuitable" in table 6 may have sand at a depth of more than 5 feet. In some of the soils, sand is at a depth of less than 5 feet and extends to a depth greater than 5 feet. Where suitability is questionable, the availability of the sand can be determined by digging test pits. Soils that have potential as a source of gravel are indicated by a footnote in table 6.

The ratings for suitability of the soils as a source of topsoil were based largely on texture and content of organic matter. Topsoil material, preferably material rich in organic matter, is used to topdress back slopes, embankments, lawns, gardens, and the like. Both the surface layer and the upper part of the subsoil, where the subsoil is suitable, were considered in making these ratings.

Factors for pond reservoir areas are those features and qualities of undisturbed soils that affect their suitability for water impoundments. The seepage rate of undisturbed soil material is the most important feature affecting pond reservoir areas. Features affecting embankments, dikes, and levees are compaction properties, stability, seepage rate after compaction, depth to bedrock, and the piping hazard.

Listed under drainage of crops and pasture are features that affect the installation and performance of surface and subsurface drainage systems. Such features are texture, permeability, relief, restricting layers, and depth to water table.

The major features affecting suitability of the soils for irrigation are available water capacity and rate of water intake. Also important are relief, the need for drainage, and depth to soil material that restricts growth of roots.

Town and Country Planning

Suburban residential development and accompanying extension of public utilities and establishment of business and recreational facilities create a need for information about soils. This information is somewhat different from the information needed for farming. Land appraisers, realtors, city planners, builders, and others need facts that will help them to determine what sites are suitable for homes and other buildings and what areas are better suited to other uses. This section provides information for homeowners who want to landscape their property and to protect it against the erosion hazards of built-up communities.

Residential development

Soil properties have an important effect on the suitability of a site for residential development, whether for a subdivision or for an individual home. Soil drainage, permeability, stability of the soil material, depth to bedrock, frequency of flooding, slope, and the hazard of erosion are important considerations.

As slope becomes steeper, the hazard of erosion increases, as does the susceptibility to land slippage. Layout and construction of streets and utilities also become more difficult.

Such soils as Brevort, Ensley, and Roscommon soils are poorly drained and have a high water table unless drained. Dry basements are difficult to maintain in these wet soils.

The section "Descriptions of the Soils" furnishes information on drainage and other features of the soils. The high water table hinders the proper functioning of septic tank absorption fields and can result in unsanitary conditions.

The rate at which water moves downward through the soil influences the soil's suitability for septic tank absorption fields. Information regarding this feature is listed in the column "permeability" in table 5. Such soils as Nester soils have moderately slow permeability and have severe limitations for septic tank absorption fields. Sandy soils that have rapid or very rapid permeability, including Eastport, Rubicon, or Shelldrake soils, allow unfiltered effluent to reach the water table and thus contaminate shallow water supplies. The column "septic tank absorption fields" in table 6, furnishes information about the features of the soils that affect their use for disposal of sewage.

Some soils provide good foundations for houses, but others do not. The columns "shrink-swell potential" in table 5, and "dwellings without basements" in table 6, will help in selecting soils that have few limitations for foundations. Such soils as Blue Lake, Emmet, and Kalkaska soils provide good foundations. The Carbondale, Lupton, Rifle, and Tawas soils have severe limitations for

foundations because of the presence of unstable organic material.

The alluvial soils are subject to flooding and, as a result, have severe limitations for homes.

Of special interest to homeowners and developers is the suitability of the soils for streets, driveways, and sidewalks. Soils of high silt content, including Bohemian and Nester soils, are subject to frost heaving. Concrete cracks readily if placed on these soils without first covering the surface of the soil with sandy and gravelly material. Soils that have a high water content and soils that have a high content of clay also cause pavements and sidewalks to crack and shift excessively.

The poorly drained Carbondale, Lupton, Rifle, and Tawas soils settle readily, especially after drainage. This settling causes cracking of pavement and an uneven surface. The columns "shrink-swell potential," in table 5, and "roadfill and local roads and streets," in table 6, will provide useful information about the use of soils for streets, driveways, and sidewalks.

Water mains, gas pipelines, communication lines, and sewerlines, which are buried in the soil, may corrode and break unless protected against certain electrobiochemical reactions. The reactions result from the inherent properties of the soil and differ according to the kind of soil.

All metals corrode to some degree when buried in the soil, and some metals corrode more rapidly in some soils than in others. Corrosivity is influenced by physical, chemical, electrical, and biological characteristics of the soil; for example, oxygen concentration, concentration of anerobic bacteria, and moisture content. Design and construction also have an influence. The likelihood of corrosion is intensified by connecting dissimilar metals, by burying metal structures at varying depths, and by extending pipelines through different kinds of soil.

In soils that have a high shrink-swell potential, stresses created by volume changes can break cast iron pipe. To prevent breakage, it may be necessary to cushion the pipes with sandy material. The column "shrink-swell potential" in table 5, furnishes estimates of the volume changes of the soils on wetting and drying. The column "corrosivity" in table 5, gives a general rating of the soils for corrosion potential.

In the construction of underground utility lines, depth to bedrock is an important factor. Ensign and Ruse soils are underlain by limestone bedrock at a depth of 10 to 20 inches. Longrie and Sundell soils are underlain by limestone at a depth of 20 to 40 inches. Information regarding this feature is listed under the column "depth to bedrock" in table 5.

Erosion and the resulting accumulation of sediment are serious concerns when planning construction on sloping soils. Because of the compaction of soil material during construction and the increased surface covered by pavement, runoff from built-up areas is likely to be 2 to 10 times as much as that from areas in farms or in trees. The runoff concentrates in streets and gutters, instead of flowing into natural waterways, and the result is flooding and deposition of sediment in lower areas. Sloping to steep areas of Bohemian, Onaway, and Trenary soils are especially subject to rapid runoff and severe erosion.

Some erosion-control measures that will help protect small residential tracts are—

1. Locating driveways, walks, and fences on the contour, if feasible, or straight across the slope.
2. Grading to make the surface level or gently sloping. The topsoil can be removed prior to grading and later used for topsoil.
3. Building diversions that will intercept runoff and keep it from flowing over erodible areas.
4. Constructing or improving waterways to prevent the formation of gullies.
5. Draining seep areas and waterlogged areas with tile drains or other facilities.

Homeowners and landscape architects need to know what kinds of soil are present in an area to be able to select flowers, shrubs, and trees for landscaping.

The ideal soils for yard and garden plants are those that have a deep root zone, a loamy texture, a balanced supply of plant nutrients, an adequate amount of organic matter, adequate available moisture capacity, good drainage, and structure that allows free movement of water. Emmet, Onaway, Trenary, and Chatham soils closely approach the ideal soil.

Such soils as Eastport, Grayling, Rubicon, and Shelldrake soils are sandy and droughty. Lawns and shrubs dry up quickly in these soils during dry periods unless they are watered frequently.

The poorly drained soils are difficult to work when wet and the surface is hard and cloddy when it dries. Seeding of lawns is difficult on these soils once they are disturbed in construction.

The section "Management by Capability Units" gives information that can be helpful in landscaping. Information given in the column "Drainage for crops and pasture" in table 6 will be useful.

Public health

Soil data have many applications to public health problems, including the problems of sewage disposal, maintenance of a pure water supply, prevention of disease, and provision of safe and adequate shelter.

Sewage lagoons, septic tank systems, and sewerlines need to be located and constructed so that seepage or drainage from them cannot pollute water supplies. Leakage from sewage lagoons built of unsuitable soil material is one source of pollution. The sandy Eastport, Grayling, Rubicon, and Shelldrake soils have rapid or very rapid permeability and may allow leakage. Wells, streams, and lakes can become contaminated by runoff from clogged absorption fields, and rapid percolation of septic tank effluent can result in pollution of shallow underground water supplies. Table 6 gives limitations on each soil for sewage lagoons, septic tank absorption fields, and shallow excavations. The soil maps show the major drainageways of the survey area and can be used as a general guide in locating filter fields.

In selecting sites for sanitary landfills, it is important to consider the topography, depth to bedrock, and drainage of an area and the characteristics of the soils, including texture, permeability, reaction, and the nature of the underlying material. The soil map helps to locate sites and identify the soils. Table 6 gives limitations to use of each soil for sanitary landfills.

The stability of the soils is of major importance in the location of sewerlines. If the gradeline is interrupted, the sewage system breaks down and a public health hazard results. Table 5 provides information on shrink-swell potential and corrosivity.

Mosquitoes and other disease-carrying insects breed in stagnant water. By use of the soil map and the soil descriptions in this survey, it is possible to identify areas subject to flooding and areas likely to be ponded from time to time because of nearly level relief or poor internal drainage. Once these potential trouble areas are located, the health hazard can be controlled by spraying to eliminate insects and installing drainage systems to remove the standing water that attracts insects.

Recreation

Recreation is a major industry in Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties. All east-west traffic in the Upper Peninsula must pass through the survey area. A network of good roads and trails provides access to recreational areas.

Within the survey area are the Hiawatha National Forest, Bay De Noc State Forest, Fayette State Park, Palms Book State Park, and part of the Pictured Rocks National Lakeshore. More than 540,000 acres of State and Federal land is in the survey area.

Many campgrounds and access sites are maintained by the Forest Service and the Michigan Department of Natural Resources. In addition to 200 lakes more than 10 acres in size, the survey area offers good fishing in its streams and in the bays of Lake Michigan and Lake Superior. The area also supports a large deer population and a variety of small game.

The kind of soil is an important factor in determining the type and location of recreational facilities that can be developed. The soil map at the back of this survey provides fundamental information needed in recreational planning. Many soils have severe limitations for campsites, play areas, picnic areas, and riding trails; other soils are highly desirable for such uses.

In this section the soils of the survey area are evaluated in terms of their limitations for recreational facilities. The soils have been placed in 12 recreation groups. Each group contains soils that have similar characteristics and similar limitations for recreational uses. The groups are rated according to their degree of limitations for the following four major uses:

Picnic areas are used for picnicking and as extensive play areas. The most desirable soils have nearly level to gently sloping topography, good drainage, freedom from flooding during periods of use, texture and consistence that provide a firm surface, and ability to support good plant cover. They should also be free of stones.

Intensive play and sport areas are developed for such use as playgrounds and athletic fields and for such organized games as baseball, tennis, and volleyball. All areas are subject to heavy foot traffic. They require a level or nearly level surface, good drainage, freedom from flooding, and texture and consistence that provide a firm surface. Areas should be free of coarse fragments and stones. The soils should be able to support a good turf.

Intensive camp sites are suitable for tent and camp trailer sites, and the accompanying activities of outdoor living, that are frequently used during the camping season. Desirable areas require little site preparation. They should be suitable as unsurfaced parking areas for cars and camp trailers, for heavy foot traffic, and for vehicular traffic. Factors considered are wetness and hazard of flooding, permeability, slope, surface soil texture, coarse fragments, and stoniness. Suitability of the soil for supporting vegetation should be considered in the final evaluation.

Paths and trails are areas that are to be used for trails, cross-country hiking, bridle paths, and other intensive uses that require the movement of people. It is assumed these areas will be used as they occur in nature and that little soil will be moved to permit this use. The most desirable soils from a physical standpoint have good trafficability. They are well drained, loamy in texture, and nearly level to sloping. They have good stability, are not subject to erosion, and are free of coarse fragments and stones. Consideration should be given to placement of paths and trails on the contour in sloping areas to help control erosion. Variability in slope gradient on paths and trails may serve to enhance interest, but slopes should not exceed 12 percent for long distances.

Ratings are expressed in terms of degrees of limitations. Soils that are relatively free of limitations or that have limitations easy to overcome are rated *slight*. Soils that have limitations that need to be recognized but can be overcome with good management and careful design are rated *moderate*. Soils that have limitations severe enough to make their use questionable are rated *severe*. Soils that need extreme measures to overcome the limitations and whose use generally is unsound or not practical are rated *very severe*. The ratings are based on soil limitations only and do not consider such features as kind of vegetation, presence of lakes, location, or other features that may affect the desirability of a site. The ratings do not imply that a soil that has a severe limitation cannot be put to a practical use if enough expense is incurred to overcome the limitation.

The material in this section is intended to provide a general guide in the location and development of parks and recreational areas. This material is not a substitute for detailed investigation of specific sites.

Additional information that may be helpful to those interested in areas for recreational development is available in the sections "Descriptions of the Soils," "Wildlife," and "Engineering Uses of the Soils."

To find the recreation group in which a soil is placed, refer to the "Guide to Mapping Units."

RECREATION GROUP 1

This group consists mainly of nearly level to gently sloping, well drained or moderately well drained, droughty sands, some of which are underlain by loam, gravel, or bedrock.

Turf is difficult to establish and to maintain on the soils in this group. The soils are droughty and have low natural fertility. These soils dry out very rapidly in spring and after periods of heavy rain. They are subject to soil blowing when dry if the surface is exposed. These soils have good bearing capacity for foot traffic when moist, but they are loose and difficult to walk on when dry.

Sandy texture and droughtiness are major limitations to use of these soils for recreation. The soils have moderate limitations for paths and trails. Extensive leveling

is needed for preparing intensive play and sports areas where slopes are more than 2 percent.

Some areas of these soils have severe limitations for some of the recreational uses. They are not so well suited to intensive play and sport areas as other areas of this group, but they can be easily adapted for the other uses. Also mosquitoes are more of a nuisance in these areas than in other areas of this group.

RECREATION GROUP 2

This group consists of nearly level to gently sloping, well drained or moderately well drained loamy sands and sands or loamy sands underlain by gravelly or loamy material.

Turf is somewhat difficult to establish and to maintain on the soils in this group. The soils dry out rapidly in spring and after periods of heavy rain. These soils have good bearing capacity for foot traffic. The surface layer is loose and dusty in some areas.

Droughtiness is the major limitation to the use of these soils for recreation. The soils have slight limitations for picnic areas. Limitations are slight to moderate for play and sports areas, but where slopes are more than 2 percent, extensive leveling is needed when preparing intensive play and sports areas. Limitations are slight for camp areas and slight to moderate for paths and trails.

RECREATION GROUP 3

This group consists mainly of sloping to moderately steep, well drained or moderately well drained sands and loamy sands and of sands and loamy sands underlain by gravelly or loamy material or bedrock.

Turf is difficult to establish and to maintain on the soils in this group. The soils are somewhat droughty, and they are more susceptible to erosion than similar soils that are less steep. They dry out rapidly in spring and after periods of heavy rain. They have good bearing capacity for foot traffic. The surface layer is loose and dusty in some areas.

Droughtiness, steepness of slope, and susceptibility to erosion are the major limitations to the use of these soils for recreation. The soils have moderate to severe limitations for picnic areas. Where slopes are more than 12 percent, limitations are severe for the placement of tables and grills for picnicking. Limitations are severe for intensive play and sports areas, because the steep slopes necessitate extensive excavating and land shaping when preparing such areas. Limitations are moderate to severe for camp areas. Where slopes are more than 8 percent, limitations are severe for the placement of tents and camping trailers. Limitations are moderate to severe for paths and trails. In sloping areas, paths and trails need to be placed on the contour to reduce the risk of erosion. Where slopes are very steep, and where they face south, areas of hilly fine sands have very severe limitations to use for all recreational purposes.

RECREATION GROUP 4

This group consists of nearly level to gently sloping, well drained or moderately well drained loams, some of which are underlain by gravelly or sandy material or bedrock.

Turf is generally easy to establish and maintain on the soils in this group. Some of the soils that are underlain by sand or gravel tend to become droughty in summer. The surface layer becomes soft and muddy for short periods after heavy rains, but generally these soils dry out rapidly after rains. The nearly level soils dry out more slowly in spring than the gently sloping soils. These soils have good bearing capacity for foot traffic.

These soils have slight limitations for use as picnic areas. Limitations are slight to moderate for play and sports areas, but where slopes are more than 2 percent, extensive leveling is required for intensive play and sports areas. Limitations are slight for camp areas and for paths and trails.

RECREATION GROUP 5

This group consists of nearly level to gently sloping, well drained or moderately well drained soils that have a surface layer of silt loam.

Turf is easy to establish and maintain. These soils dry out slowly in spring and after heavy rains. Water stands on the surface of the nearly level areas for short periods after heavy rains. When wet, the surface layer is soft and muddy and has poor bearing capacity for supporting foot traffic.

Moderately slow permeability and a silty surface layer are the major limitations to the use of these soils for recreation. The soils have moderate limitations for picnic areas, camp areas, and paths and trails. Limitations are moderate for play and sports areas, but where slopes are more than 2 percent, extensive leveling is required for intensive play and sports areas.

RECREATION GROUP 6

This group consists mainly of sloping to moderately steep, well drained or moderately well drained loams, some of which are underlain by sand, gravel, or sandstone bedrock.

Turf is somewhat difficult to establish on the soils in this group because of steepness and susceptibility to erosion. These soils generally dry out rapidly in spring and after periods of heavy rain, but the nearly level soils dry out more slowly. Runoff is slow to rapid, depending on the amount and kind of plant cover. These soils have good bearing capacity for foot traffic, but some of them are slippery when wet.

Steepness of slope and susceptibility to erosion are the major limitations to the use of these soils for recreation. The soils have moderate limitations for use as picnic areas. Where slopes are more than 15 percent, limitations are severe for placement of tables and grills for picnicking. Limitations for play and sports areas are severe because the steep slopes necessitate extensive leveling and land shaping when preparing such areas. Limitations are moderate to severe for camp areas. Where slopes are more than 8 percent, limitations are severe for the placement of tents and trailers. Limitations are slight to severe for paths and trails. In sloping areas, paths and trails need to be placed on the contour to reduce the risk of erosion.

RECREATION GROUP 7

This group consists of steep and very steep, well drained or moderately well drained sands to loams.

These soils dry out rapidly in spring and after periods of rain. Runoff is medium to rapid, depending on the soil texture and the amount and kind of plant cover. The hazard of erosion is very severe.

Steepness and the hazard of erosion are the major limitations to the use of these soils for recreation. These soils have very severe limitations for picnic areas, play and sports areas, and camp areas. The steep slopes severely limit the placement of tents, trailers, tables, and grills. Very extensive grading and shaping are required for intensive play areas. Limitations are moderate to severe for paths and trails. Paths and trails need to be placed on the contour to help reduce the risk of erosion and to facilitate use.

Many areas of these soils offer scenic views of the landscape. These soils are the most suitable sites for ski hills in the survey area.

RECREATION GROUP 8

This group consists mainly of nearly level to gently sloping, somewhat poorly drained sands, loamy sands, and sandy loams. Some of these soils are underlain by bedrock at a moderate depth.

Turf is generally easy to establish and maintain on the soils in this group, except on those that have a cemented layer. These soils have a seasonal high water table that generally is at a depth of 1 to 2 feet in winter and in spring but drops to a depth of 4 or 5 feet in summer. Runoff is slow, and water stands in depressions during wet periods. These soils dry out slowly in spring and after some periods of rain. When wet, the surface layer is soft and muddy. When dry, these soils have good bearing capacity for foot traffic.

Seasonal wetness is the major limitation to the use of these soils for recreation. These soils have moderate limitations for picnic areas, play and sports areas, camp areas, and paths and trails.

Mosquitoes and other insects are problems on the soils of this group.

RECREATION GROUP 9

This group consists mainly of nearly level to gently sloping, somewhat poorly drained soils that have a surface layer of silt loam or fine sandy loam.

Turf is generally easy to establish and maintain on the soils in this group. These soils have a seasonal high water table that generally is at a depth of 1 to 2 feet in winter and in spring but drops to a depth of 4 or 5 feet in summer. Runoff is slow, and in wet periods water stands in depressions. These soils dry out slowly in spring and after periods of rain. The surface layer is soft and muddy when wet.

Seasonal wetness, restricted permeability, and poor trafficability for foot and vehicle traffic are the major limitations to the use of these soils for recreation. These soils have severe limitations for picnic areas, play and sports areas, and camp areas and moderate limitations for paths and trails.

Mosquitoes and other insects are problems on these soils.

RECREATION GROUP 10

This group consists mainly of nearly level, poorly drained mineral soils. The soils are in depressions.

These soils have a seasonal high water table that is near the surface in winter and in spring and drops slowly in summer. In most areas the water table drops to a depth of 2 or 3 feet late in summer. Runoff is slow or very slow, and water stands for long periods in spring and after heavy rains. These soils dry out slowly. Many of these soils have a mucky or silty surface layer that is soft and muddy when wet and dusty when dry.

Wetness is the major limitation to the use of these soils for recreation. Limitations are severe for picnic areas, play and sports areas, camp areas, and paths and trails.

These soils are breeding grounds for mosquitoes and other insects. The insect problem is very severe late in spring and early in summer.

RECREATION GROUP 11

This group consists of nearly level, very poorly drained organic soils. These soils are in depressions.

Turf is difficult to maintain on the soils in this group. The soils have a high water table that is at or near the surface much of the year. It drops to a depth of about 2 feet in some areas during extended dry periods. Runoff is very slow or ponded. Water stands for long periods in spring.

These soils have very poor bearing capacity for traffic when wet. When dry, the organic material is subject to burning and blowing and it becomes dusty and dirty. The hazard of windthrow is severe on these soils.

Wetness and unstable organic material are the major limitations to the use of these soils for recreation. These soils have very severe limitations to use for picnic areas, play and sports areas, camp areas, and paths and trails.

These soils are breeding grounds for mosquitoes and other insects. The insect problem is very severe late in spring and in summer.

RECREATION GROUP 12

This group consists of nearly level to moderately steep, well drained or moderately well drained sands, gravelly sandy loams, sandy loams, and fine sandy loams that are very shallow to moderately deep over bedrock or gravelly material.

Turf is generally difficult to establish and maintain on the soils in this group, because of stoniness and droughtiness. These soils, except those in localized small depressions, generally dry out rapidly in spring and after periods of heavy rain. They have good bearing capacity for foot and vehicle traffic. Some stony areas impede traffic.

Shallow soil depth and stoniness generally are the major limitations to the use of these soils for recreation, but wetness is a limitation in some areas. The soils generally have slight to moderate limitations for picnic areas, very severe limitations for play and sports areas, moderate to severe limitations for camp areas, and slight to moderate limitations for paths and trails. Where slope is more than 2 percent, the soils have severe limitations for intensive sports areas. Where slope is more than 8 percent, limitations are severe for placement of tents and trailers. These areas cannot be leveled by grading, because of the shallow depth to bedrock.

Some areas of the soils in this group are ideally located along Lake Michigan, but they are cobbly and droughty and are not suited to camp areas and to play and sports areas. Tent stakes will not hold in them. Some areas of these soils are soft and muddy after periods of heavy rain.

Formation and Classification of the Soils[5]

This section discusses the factors that have affected formation of soils in this survey area, and it tells how the main soil-forming processes have interacted to produce the various kinds of soil. Then the current system of soil classification used in the United States is explained, and the soil series represented in the survey area are placed in some of the categories of this system. The soil series of the survey area, including a profile representative of each series, are described in the section "Descriptions of the Soils."

Factors of Soil Formation

Soils are produced by the interaction of five major factors of soil formation. These factors are: (1) the physical and mineralogical composition of the parent materials; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or topography, of the landscape; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil formation. They act on the parent material that has accumulated through various geologic processes, and they slowly change it into a natural soil body with genetically related layers called horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that is formed, and in extreme cases, such as in very young soils, it determines it almost entirely. Finally, time is needed for the parent material to be changed into a soil profile. It may be long or short, but some time is always required for horizon differentiation. Usually a long time is required for the development of distinct horizons that differ in texture. Differences in organic-matter content, on the other hand, can be produced more rapidly.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development and the results of the various combinations are unknown.

Parent material.—Parent material is the unconsolidated mass from which a soil is formed. It determines the limits of the inorganic chemical and mineralogical composition of the soil. In Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties, nearly all the parent material was deposited by the glaciers or melt waters from glaciers, or by glacial lakes. Texture of the parent material was gravel, sand, loam, clay, and organic material. The materials were deposited on outwash plains, till plains, lake plains, moraines, flood plains, and in glacial drainageways.

Figure 20 shows the major geological features of the survey area. Kalkaska, Rubicon, and Kiva soils are examples of soils in the survey area that formed on outwash plains or in glacial drainageways. Blue Lake and Munising soils commonly formed on moraines. Soils that commonly formed on till plains in the survey area include Onaway and Trenary soils. The soil mantle ranges from several inches to more than 100 feet in thickness. Limestone bedrock is at a shallow depth along Lake Michigan, and sandstone is at a shallow depth in many areas near Lake Superior.

Climate.—The climate of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties is cool and humid. Climate is relatively uniform throughout the survey area. The differences in the soils of the survey area are not the result of climatic differences. For more detailed information on the climate of the survey area, see the subsection "Climate" in the section "General Nature of the Area."

Plant and animal life.—Plants, animals, insects, bacteria, and fungi are important in the formation of soils. Gains in organic matter and nitrogen in the soil, gains or losses in plant nutrients, and changes in structure and porosity are among the changes caused by living organisms. Vegetation, dominantly hardwood and coniferous trees, has affected soil formation in the survey area more than other living organisms.

Relief.—Relief affects soil formation through its influence on drainage, erosion, plant cover, and soil temperature. Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties have an extremely variable relief, ranging from depressions to steep hills. In the hilly areas the local relief is as much as 150 to 200 feet and slope is as much as 40 percent. On the large plains, slope is less than 2 percent. Many small, nearly level areas are interspersed throughout the undulating and hilly areas. The nearly level areas receive runoff from the sloping areas. The water table is at or near the surface in depressional areas and in some level areas. Organic deposits have commonly accumulated in some poorly drained areas. The soils in depressions are somewhat poorly drained or poorly drained and have a high water table. Carbondale, Lupton, and Rifle soils are examples of the organic soils in the survey area. Charlevoix and Au Gres soils are examples of somewhat poorly drained soils, and Ensley and Roscommon soils are examples of poorly drained soils.

Time.—A long time is needed for the formation of distinct textural horizons in soils, but organic-matter content changes more rapidly. The differences in length of time that parent materials have been in place, therefore, are commonly reflected in the degree and kind of development of the soil profile.

The soils of the survey area range from a few years in age to more than 10,000 years. The younger soils have very little profile development, and the older soils have well-expressed soil horizons.

Alluvial soils are examples of young soils that lack development. Except for darkening of the surface layer, these soils retain most of the characteristics of their parent material as it was deposited by overflowing streams. Kalkaska soils are examples of older soils that have well-expressed soil horizons.

[5] R. W. JOHNSON, State soil scientist, and H. R. SINCLAIR, JR., assistant State soil scientist, Soil Conservation Service, assisted in the preparation of this section.

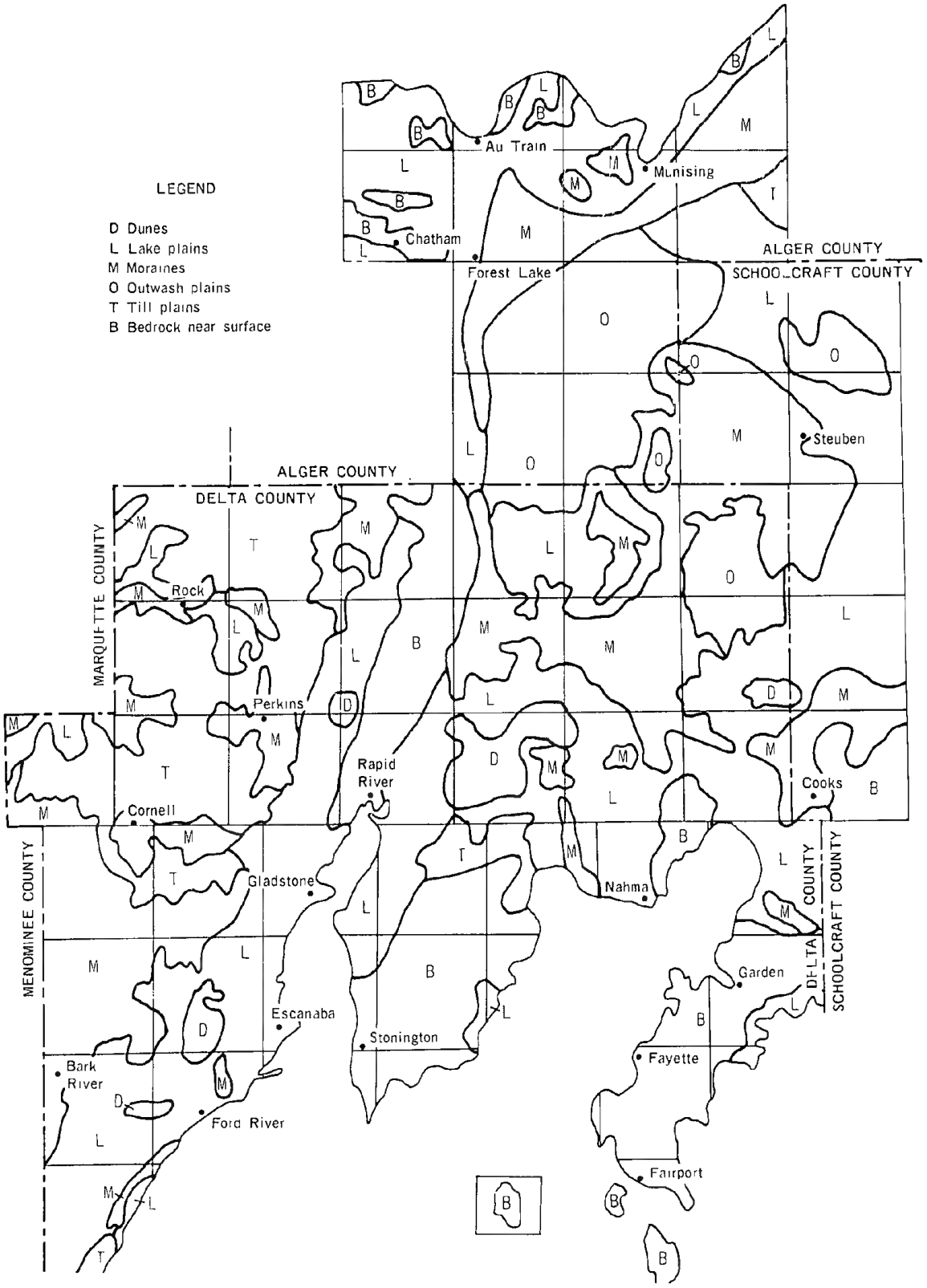

Figure 20.—**Surface geology of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties.**

Processes of Soil Formation

Several processes were involved in the formation of soil horizons in the soils of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties. These processes are: (1) accumulation of organic matter, (2) leaching of lime (calcium carbonates) and other bases, (3) reduction and transfer of iron, and (4) formation and translocation of silicate clay minerals. In most soils of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties, more than one of these processes has been active in the development of the horizons.

Organic matter has accumulated at the surface to form an A1 horizon. The A1 horizon is mixed into a plow layer, or the Ap horizon. The soils of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties have a surface layer that ranges from high to low in content of organic matter. The Nahma series is an example of soils that have a high content of organic matter in the surface layer, whereas Grayling soils have a low content of organic matter in the surface layer.

Leaching of carbonates and other bases has occurred in most of the soils in the survey area. Soil scientists generally agree that leaching of bases in soils usually precedes translocation of silicate clay minerals. Many of the soils are moderately leached to strongly leached, which has contributed to the development of soil horizons. For example, the Mancelona soils are leached of carbonates to a depth of 24 inches, whereas Alpena soils are leached to a depth of only 7 inches. The differences in the depth of leaching are a result of time, which is discussed in the section "Factors of Soil Formation."

Reduction and transfer of iron, a process called gleying, is evident in the somewhat poorly drained to very poorly drained soils. The gray color of the subsoil indicates a reduction and loss of iron. Deford soils are an example of soils in which the process has occurred. Some horizons have mottles, indicating a segregation of iron. This process has taken place in Bowers soils.

In some soils the translocation of clay minerals has contributed to horizon development. The eluviated A2 horizon above the illuviated B horizon has a platy structure, is lower in content of clay, and commonly is lighter in color. The B horizon commonly has an accumulation of clay in the form of clay films in pores and on faces of peds. Such a B horizon was probably leached of carbonates and soluble salts to a considerable extent before translocation of silicate clay took place. Leaching of bases and translocation of silicate clays are among the more important processes in horizon differentiation. Nester soils are an example of soils that have translocated silicate clays accumulated in the B horizon in the form of clay films.

In some soils of the survey area, iron, aluminum, and humus have moved from the surface layer to the B horizon. Kalkaska and Mancelona soils are examples of such soils.

Classification of Soils

Soils are classified so that their significant characteristics can be more easily remembered. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. First, through classification, and then through use of soil maps, we can apply our knowledge of soils to small specific areas or large tracts of land.

The classification system currently used was adopted by the National Cooperative Soil Survey in 1965. This system is under continual study. Therefore, readers interested in the development of the current system should search the latest available literature (7). In table 7 the soil series in the survey area are placed in some categories of the current system.

TABLE 7.—*Classification of soil series* [1]

Series	Family	Subgroup	Order
Alpena	Sandy-skeletal, mixed	Udorthentic Haploborolls	Mollisols.
Angelica	Fine-loamy, mixed, nonacid, frigid	Aeric Haplaquepts	Inceptisols.
Au Gres	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Au Gres, gravelly subsoil variant.	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Blue Lake	Sandy, mixed, frigid	Alfic Haplorthods [2]	Spodosols.
Bohemian	Fine-loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Bowers	Fine, mixed	Aquic Eutroboralfs [3]	Alfisols.
Brevort	Sandy over loamy, mixed, nonacid, frigid	Mollic Haplaquents [4]	Entisols.
Brimley	Fine-loamy, mixed, frigid	Alfic Haplaquods	Spodosols.
Bruce, coarse variant	Coarse-loamy, mixed, nonacid, frigid	Aeric Haplaquepts	Inceptisols.
Burt	Loamy, mixed, nonacid, frigid	Lithic Haplaquepts [5]	Inceptisols.
Carbondale	Euic	Hemic Borosaprists	Histosols.
Cathro	Loamy, mixed, euic	Terric Borosaprists	Histosols.
Charlevoix	Coarse-loamy, mixed, frigid	Alfic Haplaquods	Spodosols.
Chatham	Coarse-loamy, mixed, frigid	Typic Haplorthods	Spodosols.
Chippeny	Euic	Lithic Borosaprists	Histosols.
Croswell	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Dawson	Sandy or sandy-skeletal, mixed, dysic	Terric Borosaprists	Histosols.
Deerton	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Deford	Mixed, frigid	Mollic Psammaquents	Entisols.
Duel	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
East Lake	Sandy, mixed, frigid	Typic Haplorthods	Spodosols.

See footnotes at end of table.

TABLE 7.—*Classification of soil series* [1]—Continued

Series	Family	Subgroup	Order
East Lake, acid variant	Sandy, mixed, frigid	Typic Haplorthods	Spodosols.
Eastport	Mixed, frigid	Spodic Udipsamments	Entisols.
Emmet	Coarse-loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Ensign	Loamy, mixed, frigid	Lithic Haplaquods	Spodosols.
Ensley	Coarse-loamy, mixed, nonacid, frigid	Aeric Haplaquepts	Inceptisols
Fairport	Fine-loamy, mixed	Typic Eutroboralfs	Alfisols.
Gilchrist	Sandy, mixed, frigid	Typic Haplorthods	Spodosols.
Grayling	Mixed, frigid	Typic Udipsamments	Entisols.
Greenwood	Dysic	Typic Borohemists	Histosols.
Iosco	Sandy over loamy, mixed, frigid	Aqualfic Haplorthods	Spodosols.
Kalkaska	Sandy, mixed, frigid	Typic Haplorthods	Spodosols.
Karlin	Coarse-loamy, mixed, frigid	Typic Haplorthods	Spodosols.
Kawbawgam	Coarse-loamy, mixed, frigid	Entic Haplaquods	Spodosols.
Kawkawlin	Fine, mixed	Aquic Eutroboralfs	Alfisols.
Kewcenaw	Sandy, mixed, frigid	Alfic Haplorthods	Spodosols.
Kinross	Sandy, mixed, frigid	Typic Haplaquods	Spodosols.
Kiva	Sandy, mixed, frigid	Typic Haplorthods	Spodosols.
Longric	Coarse, loamy, mixed, frigid	Entic Haplorthods	Spodosols.
Lupton	Euic	Typic Borosaprists	Histosols.
Mancelona	Sandy, mixed, frigid	Alfic Haplorthods	Spodosols.
Melita	Sandy, mixed, frigid	Alfic Haplorthods	Spodosols.
Menominee	Sandy over loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Munising	Coarse-loamy, mixed, frigid	Alfic Fragiorthods	Spodosols.
Nahma	Coarse-loamy, mixed, nonacid, frigid	Histic Humaquepts	Inceptisols.
Nester	Fine, mixed	Typic Eutroboralfs [6]	Alfisols.
Onaway	Fine-loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Onota	Coarse-loamy, mixed frigid	Typic Haplorthods	Spodosols.
Otisco	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Pickford	Fine, mixed, nonacid, frigid	Aeric Haplaquepts [7]	Inceptisols.
Pickford, moderately wet	Fine, mixed	Aquic Eutroboralfs	Alfisols.
Rifle	Euic	Typic Borohemists	Histosols.
Roscommon	Mixed, frigid	Mollic Psammaquents	Entisols.
Rousseau	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Rubicon	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Ruse	Loamy, mixed, nonacid, frigid	Lithic Haplaquepts [8]	Inceptisols.
Saugatuck	Sandy, mixed, mesic, ortstein	Aeric Haplaquods [9]	Spodosols.
Shelldrake	Frigid, uncoated	Typic Quartzipsamments	Entisols.
Skanee	Coarse-loamy, mixed, frigid	Alfic Fragiaquods	Spodosols.
Steuben	Coarse-loamy, mixed, frigid	Alfic Fragiorthods	Spodosols.
Summerville	Loamy, mixed, frigid	Entic Lithic Haplorthods	Spodosols.
Sundell	Coarse-loamy, mixed, frigid	Entic Haplaquods	Spodosols.
Sundell, sandy variant	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Tacoosh	Loamy, mixed, euic	Terric Borohemists	Histosols.
Tawas	Sandy or sandy-skeletal, mixed, euic	Terric Borosaprists	Histosols.
Trenary	Coarse-loamy, mixed, frigid	Alfic Fragiorthods	Spodosols.
Wainola	Sandy, mixed, frigid	Entic Haplaquods [10]	Spodosols.
Wallace	Sandy, mixed, frigid, ortstein	Typic Haplorthods	Spodosols.
Wheatley	Mixed, frigid	Mollic Psammaquents	Entisols.
Yalmer	Sandy, mixed, frigid	Alfic Fragiorthods	Spodosols.

[1] The placement of some soil series in the current system may change as more precise information becomes available. The classification used here is as of July 1971.

[2] A part of the Blue Lake soils in the survey area have colors with hue redder than 7.5YR in the A, B, and C horizons. These colors are outside the range of the series. The soils with these colors are taxadjuncts.

[3] This soil is a taxadjunct of the Bowers series in that its solum is thinner than 24 inches and hue in the B and C horizons is 2.5YR.

[4] This soil is a taxadjunct of the Brevort series in that it has an O2 horizon as much as 12 inches thick and either a lighter colored A1 horizon or brighter colors in the B horizon, or both.

[5] This soil is a taxadjunct of the Burt series in that it has a paralithic contact rather than a lithic contact, and it is coarser textured.

[6] This soil is a taxadjunct of the Nester series in that its solum is less than 24 inches thick and hue in the B and C horizons is as much as 2.5YR.

[7] This soil is a taxadjunct of the Pickford series in that it lacks gray colors in the upper part of the profile.

[8] A part of the Ruse soils in the survey area are moderately alkaline in the solum, which is outside the range of the series.

[9] This soil is a taxadjunct of the Saugatuck series in that it has a mean annual soil temperature of less than 47° F.

[10] A part of the Wainola soils in the survey area are less than slightly acid in the C horizon, which is outside of the range for the series. Such soils are taxadjuncts.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. The six categories of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The

properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which may occur in many different climates.

Table 7 shows the soil orders that are in Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties. These are Alfisols, Entisols, Histosols, Inceptisols, Mollisols, and Spodosols.

Alfisols have a clay-enriched B horizon that is high in base saturation. Nester soils represent the Alfisols in this survey area.

Entisols are recent soils. They lack genetic horizons or have only the beginnings of such horizons. The Brevort soils are an example of Entisols in this survey area.

Histosols formed in organic material. They include soils commonly called mucks, peats, organic soils, or bogs. Cathro soils are an example of Histosols in this survey area.

Inceptisols most often are on young, but not recent, land surfaces. In this survey area, Ensley and Nahma soils are examples of Inceptisols.

Mollisols have a thick, dark-colored surface layer. Alpena soils are an example of Mollisols in this survey area.

Spodosols have an iron, aluminum, and humus-enriched B horizon. The Spodosols are represented by the Kalkaska and Mancelona soils in this survey area.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly are those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation. Examples of the suborder category are Aquepts and Orthods.

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated, or those that have pans that interfere with the growth of roots or movement of water. The features used are some properties of clays, soil temperature, and major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium).

SUBGROUP: Great groups are subdivided into subgroups, one representing the central concept of the group and others called intergrades and extragrades. Intergrade subgroups have properties of the group and also one or more properties of another great group, suborder, or order. Extragrade subgroups have properties of the group and have characteristics that are not diagnostic of another great group, suborder, or order. Examples of subgroup names are Typic Haplorthods for central concept, Alfic Haplorthods for intergrades, and Aeric Haplaquepts for extragrades.

FAMILY: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, depth, slope, consistence, and coatings. A family name consists of a series of adjectives, which are the class names for texture mineralogy, and so on, that are used as family differentiae. An example is the coarse-loamy, mixed, frigid family.

General Nature of the Area

This section contains information about land ownership, industry, transportation and climate in the survey area. It also discusses water and watershed management significant to the Area. In addition, farming statistics are provided, which will be helpful to newcomers to the survey area.

Land Ownership, Industry, and Transportation

The total land area of Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties is about 1,131,275 acres. Of this total, about 49 percent is owned by the Federal and State governments and is managed as woodland and for recreation. About 11 percent is owned by large commercial interests and is managed mainly as woodland. About 30 percent consists of smaller parcels of privately owned woodland. The remaining 10 percent is in farms, abandoned farms, resorts, and recreational and urban areas.

Tourism is a major industry in the survey area. The large publicly owned land and public recreational facilities are within a day's drive of large midwestern population centers, and they offer year-around recreational opportunities. Many private resorts are located in the area.

The major industrial employers are in Escanaba, Gladstone, and Munising, and smaller industries are scattered throughout the area. Many industries use the wood from forests in the area.

U.S. Highway No. 2 and Michigan Highway No. 28 cross the survey area from east to west. U.S. Highway No. 41, Michigan Highway No. 35, and Federal Forest Highway No. 13 are the major north-south highways. Railways serve the major cities in the area. Escanaba is the only city serviced by commercial airlines.

Climate [6]

Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties are located in the central part of Michigan's Upper Peninsula. The survey area is bounded on the north by Lake Superior and on the south by Lake Michigan.

Because of the prevailing westerly winds in this survey area, the climate varies markedly from quasi-marine near the Great Lakes, to semicontinental over the inland parts. During winter, northerly winds moving across Lake Superior produce frequent snow flurry activity along the lake shore and over the interior. The average annual snowfall exceeds 130 inches near Lake Superior. It averages about 100 inches in the inland part of the survey area and about 55 inches in the southern part near Lake Michigan. Spring is markedly delayed when the ambient air temperature associated with warm, southerly winds is cooled by the colder waters of Lake Michigan. Summers are pleasantly cool because of the

[6] This section was prepared by NORTON D. STROMMEN, climatologist for Michigan, National Weather Service, U.S. Department of Commerce.

lake breeze. Readings of 90° F., or higher, can be expected only once in every 2 years in the southern part of the survey area. Except for the immediate lakeshore areas, the warmer lake water is not effective in modifying the first outbreaks of cold weather in fall.

Climatological data for the survey area is available from Escanaba, Fayette, and Munising. Escanaba has recorded 100° temperatures only twice since 1905, once in July 1916 and once in August 1955. Fayette's maximum temperature of 96° occurred on July 12, 1936.

The Munising and inland areas can expect the temperature to exceed 90° on an average of six times each summer. The maximum temperature at Munising of 103° has occurred four times in the past 32 years.

The lowest temperatures recorded are −32° in February 1875 at Escanaba; −28° on February 25, 1928, at Fayette; and −40° on February 10, 1899, at Munising. On the average from November to March, 19 days have temperatures of zero or below. January and February are the coldest months.

The growing season in the survey area averages 120 days, but it ranges from about 80 days in the interior to nearly 140 days near the lake shores. The average date of the last freezing temperature in spring ranges from May 20 near the lakes to June 10 in the interior, and the average date of the first freeze in fall ranges from October 5 in the south to August 26 in the interior, and to October 15 in the northern area (*4*).

Precipitation is heaviest during the growing season. It averages 60 percent of the annual total during the 6-month period April to September. In Escanaba, for the last 30 years the greatest amount of precipitation ever received in a 1-month period was 9.93 inches in July, 1951. The driest month on record was October 1952, when only 0.07 inch of precipitation was measured. As much as 1.1 inches of precipitation in 1 hour, 1.3 inches in 2 hours, and 2.3 inches in 24 hours falls about once in 2 years. Twenty-four hour amounts of 3.3 inches and 4.2 inches occur about once in 10 years and once in 50 years, respectively.

Evaporation data (class A pan) available from the Germfask station, 21 miles to the east of the survey area, indicates an average evaporation total during the period May to October of 26 inches. This is about 140 percent of the normal rainfall total of 18.64 inches experienced in the same 6-month period. Recharge of the soil's water supply occurs in winter and early in spring. The capacity of the soil to hold this moisture to supplement rainfall plays an important part in the farming practices of the area, particularly in summer when the demand for water is higher.

Winter months are the cloudiest. Data for Escanaba show that November averages 19 cloudy days, 6 partly cloudy days, and 5 clear days. July averages 8 cloudy days, 12 partly cloudy days, and 11 clear days.

Other facts concerning the climate of the survey area are given in tables 8 and 9.

Water

Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties have many water resources. Lake Superior and Lake Michigan provide nearly unlimited supplies of water. About 200 lakes more than 10 acres in size are in the survey area. Several streams provide a large potential water supply, and ground-water reservoirs in much of the area yield from 10 to several hundred gallons per minute.

Because of the extensive wooded acreage, runoff is generally slow. Sandy outwash plains and moraines are

TABLE 8.—*Temperature and precipitation data*

[Based on records recorded at Fayette, 1932–61]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average total	One year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover of 1 inch or more
			Maximum temperature equal to or higher than	Minimum temperature equal to or lower than—		Less than—	More than—		
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	27.1	12.5	37	−4	1.85	0.62	3.35	28	8.3
February	28.0	11.3	37	−4	1.59	.56	2.75	27	11.8
March	34.7	19.1	46	3	1.97	1.32	3.24	26	10.8
April	46.8	30.7	60	20	2.58	1.04	4.32	5	7.0
May	58.4	40.1	69	31	3.10	1.62	4.87		
June	68.4	50.0	79	40	3.50	1.58	5.98		
July	75.1	56.7	84	47	3.30	1.35	5.49		
August	74.2	57.0	82	47	3.07	1.43	4.96		
September	65.9	50.6	77	38	3.29	1.29	5.25		
October	55.2	41.0	66	29	2.38	.88	4.02		
November	41.4	29.8	53	16	2.95	1.16	4.70	5	3.5
December	30.1	19.4	43	3	1.88	.78	3.12	18	4.9
Year	50.4	34.9	[1] 86	[2] −12	31.46	25.65	37.20	109	8.9

[1] Average annual highest temperature.

[2] Average annual lowest temperature.

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall*

[Fayette, Mich.]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28 °F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 14	April 26	May 9	May 22	June 3
2 years in 10 later than	April 9	April 21	May 4	May 17	May 29
5 years in 10 later than	March 30	April 11	April 24	May 7	May 19
Fall:					
1 year in 10 earlier than	November 10	November 1	October 22	October 5	September 20
2 years in 10 earlier than	November 15	November 6	October 27	October 10	September 25
5 years in 10 earlier than	November 26	November 17	November 7	October 21	October 6

the areas of greatest ground-water recharge. Runoff is slowed in the southern part of the area because of the heavy vegetation on the lowlands.

In Alger County the Munising Sandstone Formation yields small to moderate amounts of water of good chemical quality. This formation dips south and southeast at about 30 feet per mile and is tapped in a few places in Delta and Schoolcraft Counties. The Jacobsville Formation has little potential as a source of water. Only a few wells tap this formation. The Trenton and Black River Limestone Formations are a source of water near Chatham. Most wells are less than 100 feet deep, and some wells have been contaminated by surface pollutants (*13*).

In Delta and Schoolcraft Counties, problems concerning the quality of water are more severe than those concerning the quantity of water. The Munising and Au Train Formations yield fresh water in the northern and western parts of Delta County. These wells should be cased through overlying saline-water-bearing formations (*11, 12*). The Black River and Trenton Formations are also sources of fresh water in the northern and western parts of Delta County, but the water is saline where they are overlain by younger bedrock formations. The Trenton and Black River Formations yield saline water in Schoolcraft County (*11, 12*).

The Cataract Formation is not a source of good water in Delta and Schoolcraft Counties. The limestone and dolomite of the Richmond Group yield both fresh and saline water in areas where these rocks form the bedrock surface (*11, 12*).

Moderate to large yields of ground water can be obtained from the glacial-drift aquifers in many parts of the survey area, but in areas where the drift is absent, thin, of low permeability, or above the regional water table, ground water must be obtained from the various bedrock aquifers described above (*11, 12*).

Watershed Management [7]

The survey area forms a part of the Great Lakes watershed, from which water flows to both Lake Michigan and Lake Superior. This drainage area is a large basin that receives and disposes of precipitation in very large amounts. Increments are accounted for in several ways. A part of the water is returned to the air through evaporation and through transpiration by plants. Some of the precipitation flows overland as runoff, and some enters the soils and is held available for plant growth or slowly moves to subsurface aquifers. From the aquifers the water may replenish the ground-water supply or seep to wetlands or streams and thus maintain streams through dry periods.

The rate of infiltration of water into the soil is determined by the amount and kind of plant cover, amount of litter, and the texture of the soil. Fortunately, the survey area has highly receptive conditions. The permeability of the soils for water movement to the water table or to streams is variable, depending on soil texture and structure. The many sandy soils in the area permit rapid movement of water, but because of the sheer volume of material, they detain water over a long period of time. The finer textured soils can hold water very well but do not permit ready movement.

On the whole, the area is well protected against flash floods, soil erosion, and water shortages. Soils, vegetation, topography, and climate are all contributing factors.

Some further basis for understanding the survey area from a watershed standpoint is given in the following brief descriptions of the 14 soil associations. Specific information is provided in several of the interpretative tables of this survey. Available water capacity, permeability rates, depth to seasonal high water table, and soil hydrologic groups are listed in table 5.

Rubicon association.—These soils are on the outwash and lake plains and in some moraine areas. They are deep, well-drained, sandy soils that have very low available water capacity, but inasmuch as most areas have a deep sandy substratum, their intake and detention capacities are high. Runoff is very slow or slow, regardless of slope, cover, or use.

Damaging erosion along streambanks is potentially high, but climate and vegetation greatly reduce erosion to minor slumping.

The minor soils of this association are influenced by a high water table. They impose water storage limitations to the generally high value of the association as watershed.

Kalkaska association.—These soils are on nearly level to very steep outwash plains and moraines. These deep, well-drained, sandy soils have very low available water capacity. Moisture intake and detention storage are high.

[7] By EDWIN NEUMANN, soil scientist, Forest Service.

Runoff is very slow or slow, regardless of slope, vegetation, or land use. The soils are potentially subject to soil blowing and water erosion, but climate, vegetation, and land use greatly reduce this hazard.

The minor soils of this association are very similar to Kalkaska soils in that they have high value as watershed.

Karlin-Blue Lake association.—These soils are on nearly level to very steep moraines, till plains, and outwash plains. They are deep, well-drained soils that have a loamy subsoil overlying sand and sandy soils that have a loamy layer in the lower part of the subsoil.

Available water capacity is low to moderate. Moisture intake and detention storage in the deep substratum are high. Runoff is slow to medium but can be adversely affected by poor land use. Soil blowing and water erosion are slight to severe hazards but are not a concern under present or expected uses of the soils.

Minor soils of the association are either very similar in nature to the major soils or are of limited acreage.

Munising-Steuben association.—These soils are on nearly level to very steep moraines and till plains. They are deep, well drained and moderately well drained, loamy soils overlying sand and have a compact layer in the lower part of the subsoil.

Available water capacity is moderate. Moisture intake and retention storage are moderately high. Runoff is slow and the hazard of erosion is slight in areas that have a cover of trees. In more sloping areas, however, runoff is rapid and the hazard of erosion is severe if plant cover and the soil surface are disturbed. The compact subsoil causes some lateral water movement.

Minor soils of the association have variable value as watershed. Onota soils are limited by shallow sandstone bedrock, whereas Keweenaw and Blue Lake soils have high value for moisture intake and retention storage.

Trenary-Cathro-Tacoosh association.—These nearly level to moderately steep upland soils are on moraines and till plains. Trenary soils are deep, well drained or moderately well drained, and loamy. Available water capacity is high. Moisture intake and retention are high. Runoff is slow and the hazard of erosion is slight in areas under trees and grass. In the more sloping areas, runoff is rapid and the hazard of erosion is severe if plant cover and the soil surface are disturbed.

The other major soils in this association are the nearly level, very poorly drained Cathro and Tacoosh soils. Available water capacity is very high. Water intake is limited by degree of seasonal saturation. The nearly level or depressional terrain provides surface detention storage and slow runoff. The hazard of erosion is slight.

Onaway-Charlevoix-Tacoosh association.—These nearly level to moderately steep soils are on till plains. Onaway soils are deep, well drained or moderately well drained, and loamy. Available water capacity is high. Water intake and retention are high. Runoff is slow and the hazard of erosion is slight in areas under trees and grass, but runoff is rapid and the hazard of erosion is severe in sloping areas if plant cover and the soil surface are disturbed.

Charlevoix and Tacoosh soils are more poorly drained, than the Onaway soils and are nearly level to gently sloping. The moisture level is generally high because of high detention storage and slow to ponded runoff. The hazard of erosion is slight.

Kiva-Chippeny-Summerville association.—The Kiva and Summerville soils are nearly level to steep, well drained or moderately well drained, loamy soils underlain by sand and gravel or limestone bedrock. Available water capacity is moderate in the loamy layers and very low in the sand and gravel layers. Water storage capacity is low. The level terrain and the precipitation patterns moderate both runoff and the hazard of erosion. Runoff is slow to medium.

Chippeny soils are poorly drained organic soils overlying limestone bedrock at a depth of 20 to 51 inches. The seasonal high water table limits water intake and internal storage. Surface detention storage is high, and runoff is very slow or ponded. The hazard of erosion is slight.

Summerville-Limestone rock land-Longrie association.—These nearly level to gently sloping soils are on glacial till plains and lake plains. They are well drained or moderately well drained loamy soils. Limestone bedrock is at a depth of 0 to 40 inches.

Available water capacity is very low to moderate. Water intake and retention are very low. Runoff is slow to rapid. The hazard of erosion is severe in sloping areas if the plant cover and soil surface are disturbed.

Nahma-Ensley-Cathro association.—These nearly level soils are on till plains. They are somewhat poorly drained and poorly drained loamy soils and very poorly drained organic soils.

The seasonal high water table limits water intake and storage. Runoff is slow to ponded, and the hazard of erosion is slight.

Charlevoix-Ensley-Angelica association. —These soils are on till plains. They are nearly level to gently sloping, somewhat poorly drained and poorly drained, loamy soils. The high water table limits water intake and internal storage. Runoff is slow to ponded. The hazard of erosion is slight.

Dawson-Tawas-Rousseau association.—These soils are on relict dunes. They are nearly level, very poorly drained organic soils and gently sloping to very steep, deep, well drained or moderately well drained, sandy soils.

Rousseau soils have low available water capacity. Water intake and detention storage are high. Runoff is slow to medium. The hazard of erosion is generally severe, but it is slight under natural forest cover.

Dawson and Tawas soils are organic. They have a high water table that limits water intake and internal storage. Runoff is very slow to ponded. The hazard of erosion is slight.

Kalkaska-Tawas-Carbondale association.—These nearly level to very steep soils are on outwash plains, lake plains, and moraines.

Kalkaska soils are deep, well drained or moderately well drained, sandy soils. Available water capacity is very low, but water intake and detention storage are high. Runoff is very slow or slow under all conditions, reducing the hazard of erosion.

Tawas and Carbondale soils are very poorly drained organic soils. Intake capacity is low. Runoff is very slow to ponded.

Tawas-Carbondale-Roscommon association.—These soils are on outwash plains and lake plains. They are nearly level, poorly drained and very poorly drained, sandy soils and organic soils. The high water table severely limits

water intake and internal storage. Runoff is very slow to ponded. The hazard of erosion is slight.

Roscommon-Tawas association.—These soils are on lake plains and outwash plains. They are nearly level, poorly drained, sandy soils and nearly level, very poorly drained, organic soils. The high water table limits water intake and storage. Runoff is very slow or ponded. The hazard of erosion is slight.

Farming

The total land area in Delta County and Hiawatha National Forest of Alger and Schoolcraft Counties is about 1,131,275 acres. The percentage of land in farms used for raising livestock and crops, not including timberland, is 9.2 percent in Delta County, 3.2 percent in Alger County, and 1.4 percent in Schoolcraft County (*5*).

Most of the farming in the survey area is in the western and southern parts of Delta County. The 1964 Census of Agriculture lists 526 farms in Delta County (*9*). This is a decrease of 86 farms since 1959. About 117,150 acres was in farms in Delta County in 1964, but 42,844 acres of this was farm woodland.

Of the 526 farms in Delta County, 225 were miscellaneous and unclassified, 208 were classified as dairy farms, 47 as other livestock farms, 33 as general farms, and 13 as field-crop farms.

Hay is the most important crop in Delta County. In 1964, 10,234 acres of alfalfa or alfalfa mixture was harvested, 8,610 acres of mixed hay, and 432 acres of wild hay. Also harvested was 7,076 acres of oats and 1,289 acres of corn for silage or fodder. Only 44 acres of corn for grain was produced. About 506 acres of potatoes and 389 acres of green peas were harvested in 1964.

The major farming area in the Alger County part of the survey area is near Chatham. Hay and oats are the major crops. In the Schoolcraft County part of the survey area, the soils near Cooks produce mainly hay.

Literature Cited

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2v., illus.

(2) Michigan Department of State Highways. 1970. Field manual of soils engineering. Ed. 5, 474 pp., illus.

(3) Michigan State University. 1972. Fertilizer recommendations for Michigan vegetables and field crops. Ext. Bul. E. 550, 32 pp.

(4) ———— 1965. Freeze bulletin. Research Report 26, 40 pp.

(5) ———— 1968. Land use in Michigan. Ext. Bul. 610, Natural Resource Series, 38 pp.

(6) United States Department of Agriculture. 1951. Soil survey manual. Agr. Handbook No. 18, 503 pp., illus.

(7) ———— 1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued in March 1967 and September 1967]

(8) ———— 1966. Land capability classification. Agr. Handbook No. 210, 21 pp.

(91) United States Department of Commerce. 1967. 1964 United States Census of Agriculture; statistics for the state and counties, Michigan. Vol. 11, 419 pp.

(0) United States Department of Defense. 1968. Unified soil classification system for roads, airfields, embankments, and foundations. MIL–STD–619B. 30 pp., illus.

(11) Sinclair, William C. 1960. Reconnaissance of the ground-water resources of Schoolcraft County, Michigan. Michigan Geol. Survey Prog. Rept. 22. 84 pp.

(12) ———— 1960. Reconnaissance of the ground-water resources of Delta County, Michigan. Michigan Geol. Survey Prog. Rept. 23. 93 pp.

(13) Vanlier, Kenneth E. 1963. Reconnaissance of the groundwater resources of Alger County, Michigan. Michigan Geol. Survey, Water Investigation 1. 55 pp.

Glossary

Acidity. See Reaction, soil.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkalinity. See Reaction, soil.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers.

Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottling below 6 to 16 inches in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Drumlin (geology). A streamlined hill or ridge of glacial deposits with a long axis that is parallel to the direction of flow of a former glacier.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of the landform.

Glacial outwash. Sandy and gravelly materials deposited in layers on plains or in old glacial drainageways by water from melting glaciers.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Green manure (agronomy). A crop grown for the purpose of being turned under in an early stage of maturity or soon after maturity for soil improvement.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon. The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residue.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Kame (geology). An irregular, short ridge or hill of stratified glacia drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed by lowering of the water level or elevation of the land.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Mineral soil. Soil composed mainly of inorganic (mineral) material and low in content of organic material. Its bulk density is greater than that of organic soil.

Miscellaneous land type. A mapping unit for areas of land that have little or no natural soil; or that are too nearly inaccessible for orderly examination; or that occur where, for other reasons, it is not feasible to classify the soil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Muck. Well-decomposed, organic soil material developed from peat. Muck generally has a higher mineral or ash content than peat and the original plant parts cannot be identified. See peat.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Organic soil. A general term applied to a soil or to a soil horizon that consists primarily of organic matter, such as peat soils, muck soils, and peaty soil layers. In chemistry, organic refers to the compounds of carbon.

Ortstein. The B horizon in a Spodosol that is cemented by accumulated sesquioxides, by organic matter, or by both.

Peat. Unconsolidated soil material, largely undecomposed organic matter that has accumulated where there has been excess moisture.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Phase, soil. A subdivision of a soil series or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil series, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher.
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Relief. The elevations or inequalitites of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Taxadjunct. Soils handled as taxadjuncts are considered adjuncts but not parts of the series furnishing a name for their identifi-

cation. They are so much like the soils of the defined series in morphology, composition, and behavior that little would be gained by adding a new series.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Valley train. The material deposited by the stream in the valley below a glacier.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

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GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the series to which the mapping unit belongs. In referring to a capability unit, to a woodland suitability group, or to a recreation group, read the introduction to the section it is in for general information about its management.

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	Recreation group	
			Symbol	Page	Number	Number	Page
Ad	Alluvial land	11	VIIwc-1 (L-4c)	77	---	10	128
AlC	Alpena gravelly sandy loam, 0 to 12 percent slopes	14	VIs-2 (Ga)	77	2f1	12	128
AuB	Au Gres sand, 0 to 6 percent slopes	15	IVwc-2 (5b)	76	3s3	8	128
AvA	Au Gres loamy sand, gravelly subsoil variant, 0 to 4 percent slopes	15	IIIwc-5 (4b)	74	3s3	8	128
BlB	Blue Lake sand, 0 to 6 percent slopes	16	IIIs-4 (4a)	75	2s1	1	126
BlD	Blue Lake sand, 6 to 18 percent slopes	16	IVe-9 (4a)	76	2s1	3	127
BlE	Blue Lake sand, 18 to 40 percent slopes	16	VIIe-2 (4a)	77	2s2	7	127
BoB	Bohemian fine sandy loam, 0 to 6 percent slopes	18	IIe-3 (2.5a)	72	2o1	4	127
BoD	Bohemian fine sandy loam, 6 to 18 percent slopes	18	IVe-4 (2.5a)	75	2o1	6	127
Bp	Borrow pits	18	VIIIs-3	79	---	--	---
BrA	Bowers silt loam, 0 to 4 percent slopes	19	IIwc-2 (1.5b)	72	2o5	9	128
Bs	Brevort mucky loamy sand	19	IIIwc-10 (4/2c)	75	5w1	10	128
BtA	Brimley fine sandy loam, 0 to 4 percent slopes	20	IIwc-6 (2.5b)	73	2o5	9	128
Bu	Bruce mucky fine sandy loam, coarse variant	21	IIwc-6 (3c)	73	4w1	10	128
BwC	Burt mucky sandy loam, 2 to 12 percent slopes	21	VIIwc-2 (Rbc)	77	4w1	10	128
Cb	Carbondale, Lupton, and Rifle soils	22	VIIwc-15 (Mc)	78	5w2	11	128
Ch	Cathro muck	23	VIIwc-10 (M/3c)	78	5w2	11	128
Ck	Cathro and Tacoosh mucks	23	VIIwc-10 (M/3c)	78	5w2	11	128
ClA	Charlevoix sandy loam, 0 to 4 percent slopes	23	IIwc-6 (3b)	73	2o5	8	128
CmA	Chatham fine sandy loam, 0 to 2 percent slopes	24	IIs-2 (3a)	73	2o1	4	127
CmB	Chatham fine sandy loam, 2 to 6 percent slopes	24	IIe-3 (3a)	72	2o1	4	127
CmD	Chatham fine sandy loam, 6 to 18 percent slopes	24	IIIe-6 (3a)	73	2o1	6	127
Cn	Chippeny muck	25	VIIwc-10 (M/Rc)	78	5w2	11	128
CrA	Croswell sand, 0 to 4 percent slopes	26	IVs-4 (5a)	76	2s3	1	126
Da	Dawson peat	26	VIIIwc-1 (Mc-a)	78	---	11	128
Dd	Dawson and Greenwood peats	26	VIIIwc-1 (Mc-a)	78	---	11	128
DeB	Deerton sand, 0 to 6 percent slopes	28	VIs-1 (4/Ra)	76	3s1	1	126
DeD	Deerton sand, 6 to 18 percent slopes	28	VIs-1 (4/Ra)	76	3s1	3	127
DlB	Deerton-Burt complex, 0 to 6 percent slopes	28	VIs-1 (4/Ra, Rbc)	76	---	12	128
	Deerton part	--	----------	--	3s1	--	---
	Burt part	--	----------	--	4w1	--	---
Dm	Deford loamy fine sand	28	IIIwc-6 (4c)	75	5w1	10	128
DuB	Duel loamy sand, 0 to 6 percent slopes	29	IVs-1 (4/Ra)	76	3s1	1	126
EaB	East Lake sand, 0 to 6 percent slopes	30	IVs-4 (5a)	76	3s1	1	126
EcB	East Lake loamy sand, acid variant, 0 to 6 percent slopes	30	IIIs-4 (4a-a)	75	2s1	2	127
EcD	East Lake loamy sand, acid variant, 6 to 18 percent slopes	30	IVe-9 (4a-a)	76	2s1	3	127
EdB	Eastport sand, 0 to 6 percent slopes	31	VIIs-1 (5.3a)	78	2s3	1	126
EeB	Eastport-Roscommon sands, 0 to 6 percent slopes	31	VIIs-1 (5.3a, 5c)	78	---	1	126
	Eastport part	--	----------	--	2s3	--	---
	Roscommon part	--	----------	--	5w1	--	---
EmA	Emmet sandy loam, 0 to 2 percent slopes	32	IIs-2 (3a)	73	2o1	4	127

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	Recreation group	
			Symbol	Page	Number	Number	Page
EmB	Emmet sandy loam, 2 to 6 percent slopes	32	IIe-3 (3a)	72	2o1	4	127
EmC	Emmet sandy loam, 6 to 12 percent slopes	32	IIIe-6 (3a)	73	2o1	6	127
EnA	Ensign fine sandy loam, 0 to 3 percent slopes	33	VIIwc-2 (Rbc)	77	3d1	8	128
Es	Ensley and Angelica soils	34	IIwc-6 (3c, 2.5c)	73	4w1	10	128
FaA	Fairport silt loam, 0 to 2 percent slopes	35	IIIs-2 (2/Ra)	75	2o3	5	127
FaB	Fairport silt loam, 2 to 6 percent slopes	35	IIIe-8 (2/Ra)	74	2o3	5	127
GcB	Gilchrist sand, 0 to 6 percent slopes	35	IIIs-4 (4a)	75	2s1	2	127
GrB	Grayling sand, 0 to 6 percent slopes	36	VIIs-1 (5.7a)	78	4s1	1	126
GrD	Grayling sand, 6 to 18 percent slopes	36	VIIs-1 (5.7a)	78	4s1	3	127
Gw	Greenwood peat	37	VIIIwc-1 (Mc-a)	78	---	11	128
IoB	Iosco sand, 0 to 6 percent slopes	37	IIIwc-9 (4/2b)	75	3s3	8	128
KaB	Kalkaska sand, 0 to 6 percent slopes	38	IVs-4 (5a)	76	3s1	1	126
KaD	Kalkaska sand, 6 to 18 percent slopes	38	VIs-1 (5a)	77	3s1	3	127
KaE	Kalkaska sand, 18 to 40 percent slopes	39	VIIs-1 (5a)	78	3s2	7	127
KdB	Karlin sandy loam, 0 to 6 percent slopes	40	IIIs-4 (4a)	75	2s1	4	127
KdD	Karlin sandy loam, 6 to 18 percent slopes	40	IVe-9 (4a)	76	2s1	6	127
KgC	Kawbawgam sandy loam, 0 to 10 percent slopes	40	IIIwc-4 (3/Rbc)	74	2o5	8	128
KlA	Kawkawlin silt loam, 0 to 2 percent slopes	41	IIwc-2 (1.5b)	72	2o3	9	128
KnB	Keweenaw loamy sand, 0 to 6 percent slopes	42	IIIs-4 (4a-a)	75	2s1	2	127
KnD	Keweenaw loamy sand, 6 to 18 percent slopes	42	IVe-9 (4a-a)	76	2s1	3	127
Kr	Kinross mucky sand	42	VIIwc-3 (5c)	77	5w1	10	128
KsB	Kiva sandy loam, 0 to 6 percent slopes	43	IIIs-4 (4a)	75	2f1	4	127
KsD	Kiva sandy loam, 6 to 20 percent slopes	43	IVe-9 (4a)	76	2f1	6	127
Lb	Lake beaches	43	VIIIs-1	78	---	--	---
Lm	Limestone rock land	43	VIIIs-2	78	---	12	128
LoA	Longrie sandy loam, 0 to 2 percent slopes	45	IIIs-2 (3/Ra)	75	2o1	4	127
LoB	Longrie sandy loam, 2 to 6 percent slopes	45	IIIe-8 (3/Ra)	74	2o1	4	127
LsD	Longrie and Summerville sandy loams, 6 to 18 percent slopes	45	VIe-3 (3/Ra, Ra)	76	---	12	128
	Longrie part	--	----------	--	2o1	--	---
	Summerville part	--	----------	--	3d1	--	---
Ma	Made land	46	VIIIs-3	79	---	--	---
McB	Mancelona loamy sand, 0 to 6 percent slopes	46	IIIs-4 (4a)	75	2s1	2	127
McD	Mancelona loamy sand, 6 to 18 percent slopes	46	IVe-9 (4a)	76	2s1	3	127
Mh	Marsh	46	VIIIwc-2	78	---	--	---
MlB	Melita sand, 0 to 6 percent slopes	47	IVs-4 (5/2a)	76	2s1	1	126
MnB	Menominee loamy sand, 0 to 6 percent slopes	48	IIIs-4 (4/2a)	75	2s1	2	127
MnD	Menominee loamy sand, 6 to 18 percent slopes	48	IVe-9 (4/2a)	76	2s1	3	127
MuB	Munising sandy loam, 0 to 6 percent slopes	49	IIe-3 (3a-a)	72	2d1	4	127
MuD	Munising sandy loam, 6 to 18 percent slopes	49	IVe-4 (3a-a)	75	2d1	6	127
MuE	Munising sandy loam, 18 to 40 percent slopes	50	VIIe-2 (3a-a)	77	2d2	7	127
Nh	Nahma loam	50	IIIwc-4 (3/Rbc)	74	4w1	10	128
NsA	Nester silt loam, 0 to 2 percent slopes	51	IIs-1 (1.5a)	73	2o3	5	127
NsB	Nester silt loam, 2 to 6 percent slopes	51	IIe-1 (1.5a)	71	2o3	5	127
OnA	Onaway fine sandy loam, 0 to 2 percent slopes	52	IIe-2 (2.5a)	71	2o1	4	127
OnB	Onaway fine sandy loam, 2 to 6 percent slopes	52	IIe-2 (2.5a)	71	2o1	4	127
OnC	Onaway fine sandy loam, 6 to 12 percent slopes	52	IIIe-5 (2.5a)	73	2o1	6	127
OnD	Onaway fine sandy loam, 12 to 18 percent slopes	53	IVe-4 (2.5a)	75	2o1	6	127

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	Recreation group	
			Symbol	Page	Number	Number	Page
OoF	Onota-Chippeny complex, steep	53	VIIe-3 (3/Ra, M/Rc)	77	---	7	127
	Onota part	--	------------------	--	2r1	--	---
	Chippeny part	--	------------------	--	5w2	--	---
OrB	Onota-Deerton complex, 0 to 6 percent slopes	53	IIIe-8 (3/Ra, 4/Ra)	74	---	4	127
	Onota part	--	------------------	--	2o1	--	---
	Deerton part	--	------------------	--	3s1	--	---
OrD	Onota-Deerton complex, 6 to 18 percent slopes	54	VIe-3 (3/Ra, 4/Ra)	76	---	6	127
	Onota part	--	------------------	--	2o1	--	---
	Deerton part	--	------------------	--	3s1	--	---
OtB	Otisco loamy sand, 0 to 6 percent slopes	54	IIIwc-5 (4b)	74	3s3	8	128
Pc	Pickford silt loam	55	IIIwc-1 (1c)	74	4w1	10	128
PfA	Pickford silt loam, moderately wet, 0 to 4 percent slopes	55	IIIwc-2 (1b)	74	4w1	9	128
PkA	Pickford complex, 0 to 4 percent slopes	56	IIIwc-2 (1b, 1c)	74	4w1	9	128
Rc	Roscommon mucky sand	57	VIIwc-3 (5c)	77	5w1	10	128
RkB	Roscommon-Kalkaska sands, 0 to 6 percent slopes	57	VIIwc-3 (5c, 5a)	77	---	10	128
	Roscommon part	--	------------------	--	5w1	--	---
	Kalkaska part	--	------------------	--	3s1	--	---
RoB	Rousseau fine sand, 0 to 6 percent slopes	57	IIIs-4 (4a)	75	2s1	1	126
RoD	Rousseau fine sand, 6 to 18 percent slopes	58	IVe-9 (4a)	76	2s1	3	127
RsD	Rousseau fine sand, hilly	58	VIIs-1 (4a)	78	2s2	3	127
RuB	Rubicon sand, 0 to 6 percent slopes	59	VIIs-1 (5.3a)	78	2s3	1	126
RuD	Rubicon sand, 6 to 18 percent slopes	59	VIIs-1 (5.3a)	78	2s3	3	127
RuE	Rubicon sand, 18 to 40 percent slopes	59	VIIs-1 (5.3a)	78	2s4	7	127
Rv	Ruse silt loam	59	VIIwc-2 (Rbc)	77	4w1	10	128
ScA	Saugatuck sand, 0 to 3 percent slopes	60	VIIwc-3 (5b-h)	77	5w1	8	128
ShB	Shelldrake sand, 0 to 8 percent slopes	60	VIIs-1 (5.3a)	78	2s3	1	126
SkB	Skanee sandy loam, 0 to 6 percent slopes	61	IIwc-6 (3b-a)	73	2o5	8	128
StB	Steuben fine sandy loam, 0 to 6 percent slopes	62	IIe-3 (3a-a)	72	2d1	4	127
StD	Steuben fine sandy loam, 6 to 18 percent slopes	62	IVe-4 (3a-a)	75	2d1	6	127
SuA	Summerville fine sandy loam, 0 to 4 percent slopes	63	VIs-3 (Ra)	77	3d1	12	128
SvA	Sundell fine sandy loam, 0 to 4 percent slopes	64	IIIwc-4 (3/Rbc)	74	2o5	8	128
SwA	Sundell loamy fine sand, sandy variant, 0 to 4 percent slopes	65	IVwc-1 (4/Rbc)	76	3s3	8	128
Ta	Tawas muck	66	VIIwc-5 (M/4c)	78	5w2	11	128
TrA	Trenary fine sandy loam, 0 to 2 percent slopes	67	IIe-2 (3a)	71	2d1	4	127
TrB	Trenary fine sandy loam, 2 to 6 percent slopes	67	IIe-2 (3a)	71	2d1	4	127
TrC	Trenary fine sandy loam, 6 to 12 percent slopes	67	IIIe-5 (3a)	73	2d1	6	127
TrD	Trenary fine sandy loam, 12 to 18 percent slopes	67	IVe-4 (3a)	75	2d1	6	127
WaA	Wainola fine sand, 0 to 4 percent slopes	68	IIIwc-5 (4b)	74	3s3	8	128
WlB	Wallace sand, 0 to 6 percent slopes	69	VIIs-1 (5a-h)	78	2s3	1	126
WlD	Wallace sand, 6 to 18 percent slopes	69	VIIs-1 (5a-h)	78	2s3	3	127
Wm	Wheatley mucky loamy sand	69	IIIwc-6 (5c)	75	5w1	10	128
YaB	Yalmer sand, 0 to 6 percent slopes	70	IIIs-4 (4a-a)	75	2s1	2	127
YaD	Yalmer sand, 6 to 18 percent slopes	70	IVe-9 (4a-a)	76	2s1	3	127

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To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).

SOIL ASSOCIATIONS*

DOMINANTLY SANDY SOILS OF THE OUTWASH PLAINS, LAKE PLAINS, AND MORAINES

1 — Rubicon association: Nearly level to very steep, well-drained, sandy soils

2 — Kalkaska association: Nearly level to very steep, well drained and moderately well drained, sandy soils

3 — Karlin-Blue Lake association: Nearly level to very steep, well-drained, loamy and sandy soils

DOMINANTLY LOAMY SOILS OF THE TILL PLAINS AND MORAINES

4 — Munising-Steuben association: Nearly level to very steep, well drained and moderately well drained, dominantly loamy soils

5 — Trenary-Cathro-Tacoosh association: Nearly level to moderately steep, well drained and moderately well drained, loamy soils, and nearly level, very poorly drained organic soils

6 — Onaway-Charlevoix-Tacoosh association: Nearly level to moderately steep, well drained to somewhat poorly drained, loamy soils and nearly level, very poorly drained organic soils

DOMINANTLY LOAMY SOILS OF THE OUTWASH PLAINS, TILL PLAINS, AND BEDROCK BENCHES

7 — Kiva-Chippeny-Summerville association: Nearly level to steep, well drained and moderately well drained, loamy soils underlain by sand and gravel or limestone bedrock, and nearly level, very poorly drained organic soils underlain by limestone bedrock

8 — Summerville-Limestone rock land-Longrie association: Nearly level to moderately steep, well drained and moderately well drained, loamy soils underlain by limestone bedrock

DOMINANTLY LOAMY SOILS OF THE TILL PLAINS

9 — Nahma-Ensley-Cathro association: Nearly level, poorly drained, loamy soils and nearly level, very poorly drained organic soils

10 — Charlevoix-Ensley-Angelica association: Nearly level to gently sloping, somewhat poorly drained and poorly drained, loamy soils

DOMINANTLY SANDY AND ORGANIC SOILS OF THE LAKE PLAINS AND OUTWASH PLAINS

11 — Dawson-Tawas-Rousseau association: Nearly level, very poorly drained organic soils and gently sloping to very steep, well drained and moderately well drained sandy soils

12 — Kalkaska-Tawas-Carbondale association: Nearly level to very steep, well drained and moderately well drained, sandy soils and nearly level, very poorly drained organic soils

13 — Tawas-Carbondale-Roscommon association: Nearly level, very poorly drained organic soils and poorly drained, sandy soils

14 — Roscommon-Tawas association: Nearly level, poorly drained, sandy soils and nearly level, very poorly drained organic soils

* Texture named in soil associations is that of the surface layer.

Compiled 1976

N

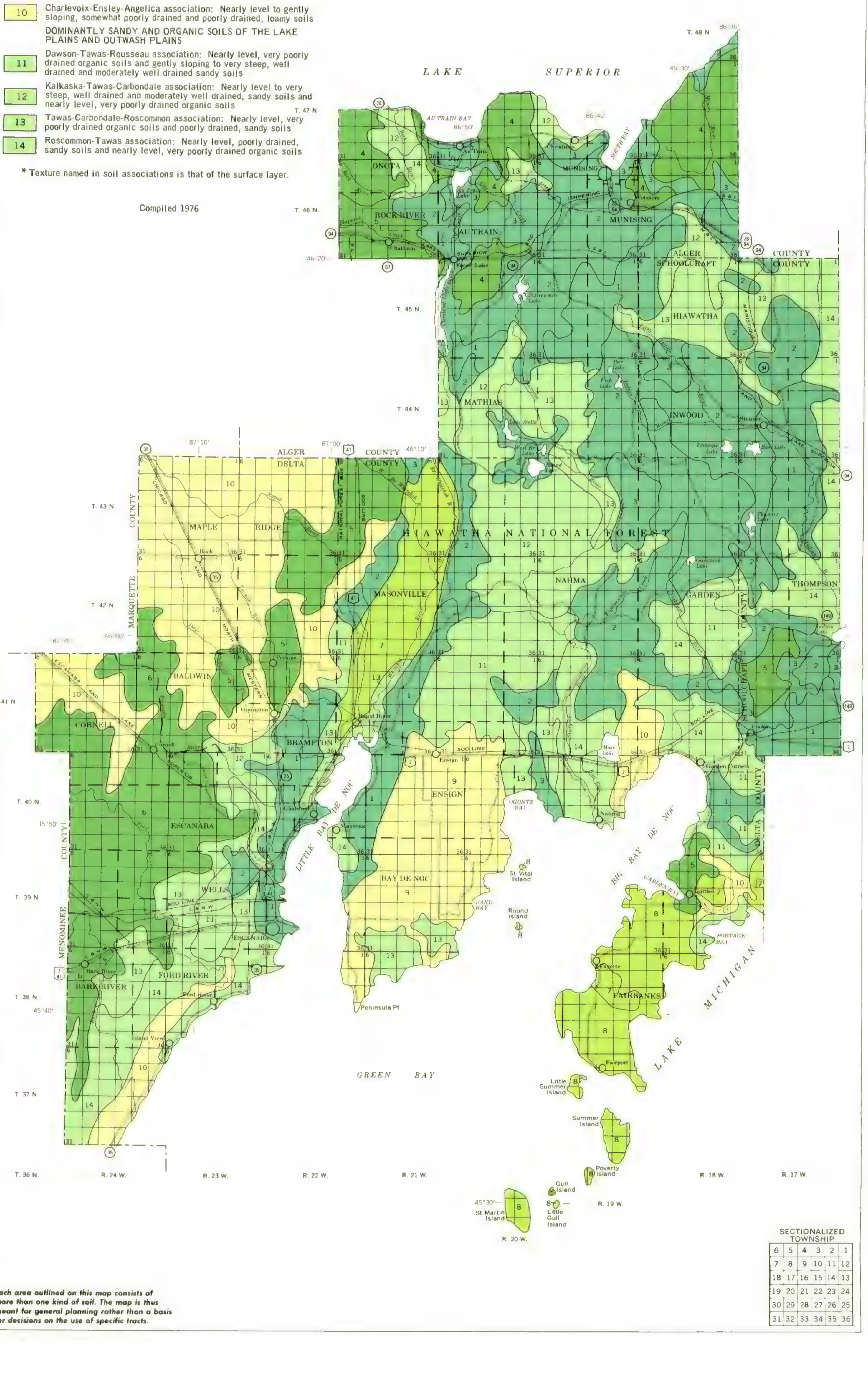
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST SERVICE

MICHIGAN AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

DELTA COUNTY AND HIAWATHA NATIONAL FOREST OF ALGER AND SCHOOLCRAFT COUNTIES, MICHIGAN

Scale 1:316,800
1 0 1 2 3 4 5 Miles



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

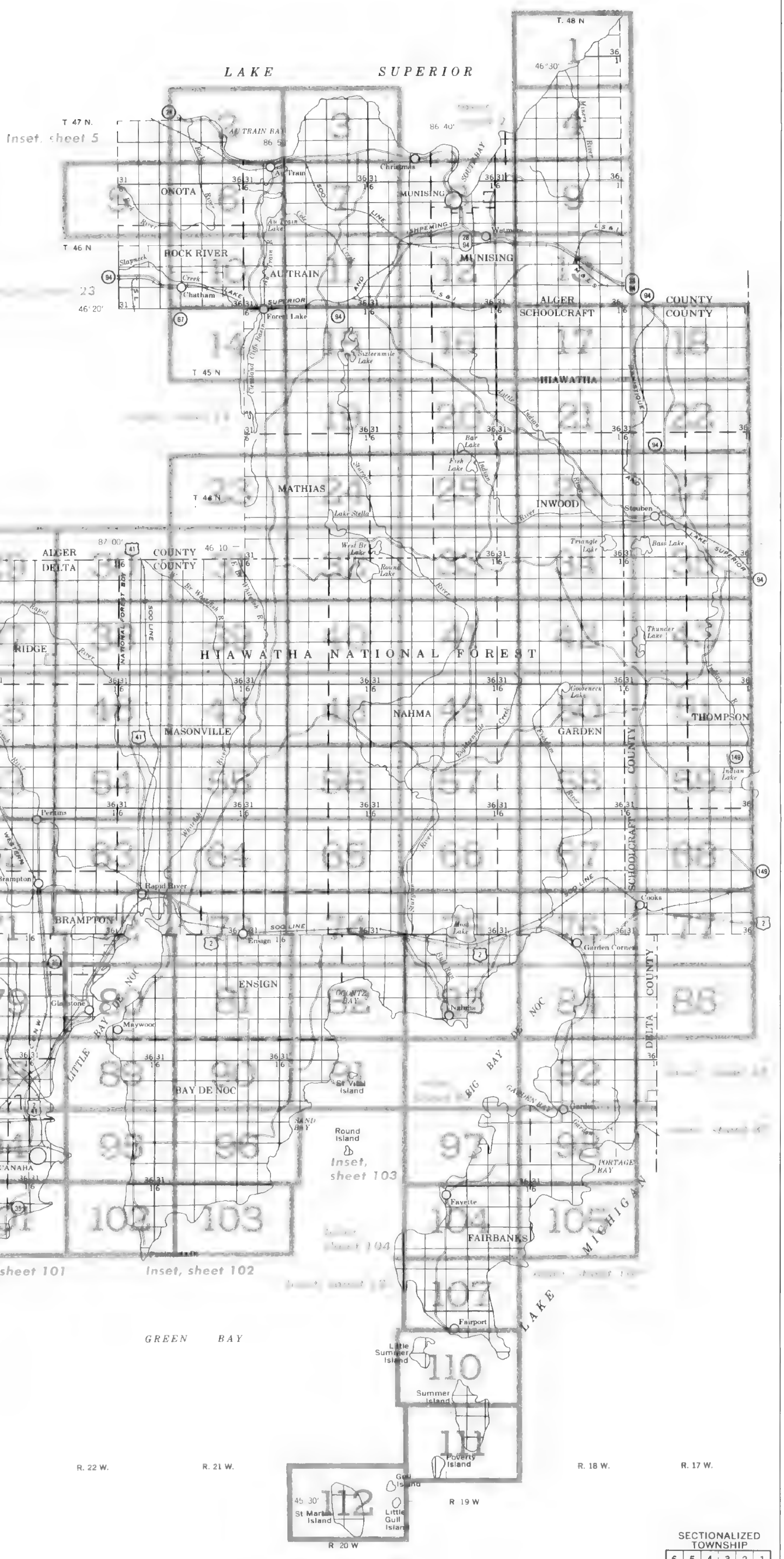
N

INDEX TO MAP SHEETS

DELTA COUNTY AND HIAWATHA NATIONAL FOREST OF ALGER AND SCHOOLCRAFT COUNTIES, MICHIGAN

Scale 1:316,800

1 0 1 2 3 4 5 Miles



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE AND FOREST SERVICE

DELTA COUNTY AND HIAWATHA NATIONAL FOREST OF ALGER AND SCHOOL

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter A, B, C the class of slope. Most slopes without a slope letter are those of nearly level soils, but s types that have a considerable range of slope.

SYMBOL	NAME
Ad	Alluvial land
AlC	Alpena gravelly sandy loam, 0 to 12 percent slopes
AuB	Au Gres sand, 0 to 6 percent slopes
AvA	Au Gres loamy sand, gravelly subsoil variant, 0 to 4 percent slopes
BlB	Blue Lake sand, 0 to 6 percent slopes
BlD	Blue Lake sand, 6 to 18 percent slopes
BlE	Blue Lake sand, 18 to 40 percent slopes
BoB	Bohemian fine sandy loam, 0 to 6 percent slopes
BoD	Bohemian fine sandy loam, 6 to 18 percent slopes
Bp	Borrow pits
BrA	Bowers silt loam, 0 to 4 percent slopes
Bs	Brevort mucky loamy sand
BtA	Brimley fine sandy loam, 0 to 4 percent slopes
Bu	Bruce mucky fine sandy loam, coarse variant
BwC	Burt mucky sandy loam, 2 to 12 percent slopes
Cb	Carbondale, Lupton and Rifle soils
Ch	Cathro muck
Ck	Cathro and Tacoosh mucks
ClA	Charlevoix sandy loam, 0 to 4 percent slopes
CmA	Chatham fine sandy loam, 0 to 2 percent slopes
CmB	Chatham fine sandy loam, 2 to 6 percent slopes
CmD	Chatham fine sandy loam, 6 to 18 percent slopes
Cn	Chippeny muck
CrA	Croswell sand, 0 to 4 percent slopes
Da	Dawson peat
Dd	Dawson and Greenwood peats
DeB	Deerton sand, 0 to 6 percent slopes
DeD	Deerton sand, 6 to 18 percent slopes
DlB	Deerton-Burt complex, 0 to 6 percent slopes
Dm	Deford loamy fine sand
DuB	Duel loamy sand, 0 to 6 percent slopes
EaB	East Lake sand, 0 to 6 percent slopes
EcB	East Lake loamy sand, acid variant, 0 to 6 percent slopes
EcD	East Lake loamy sand, acid variant, 6 to 18 percent slopes
EdB	Eastport sand, 0 to 6 percent slopes
EeB	Eastport-Roscommon sands, 0 to 6 percent slopes
EmA	Emmet sandy loam, 0 to 2 percent slopes
EmB	Emmet sandy loam, 2 to 6 percent slopes
EmC	Emmet sandy loam, 6 to 12 percent slopes
EnA	Ensign fine sandy loam, 0 to 3 percent slopes
Es	Ensley and Angelica soils
FaA	Fairport silt loam, 0 to 2 percent slopes
FaB	Fairport silt loam, 2 to 6 percent slopes
GcB	Gilchrist sand, 0 to 6 percent slopes
GrB	Grayling sand, 0 to 6 percent slopes
GrD	Grayling sand, 6 to 18 percent slopes
Gw	Greenwood peat
IoB	Iosco sand, 0 to 6 percent slopes
KaB	Kalkaska sand, 0 to 6 percent slopes
KaD	Kalkaska sand, 6 to 18 percent slopes
KaE	Kalkaska sand, 18 to 40 percent slopes
KdB	Karlin sandy loam, 0 to 6 percent slopes
KdD	Karlin sandy loam, 6 to 18 percent slopes
KgC	Kawbawgam sandy loam, 0 to 10 percent slopes
KlA	Kawkawlin silt loam, 0 to 2 percent slopes
KnB	Keweenaw loamy sand, 0 to 6 percent slopes
KnD	Keweenaw loamy sand, 6 to 18 percent slopes
Kr	Kinross mucky sand
KsB	Kiva sandy loam, 0 to 6 percent slopes
KsD	Kiva sandy loam, 6 to 20 percent slopes
Lb	Lake beaches
Lm	Limestone rock land
LoA	Longrie sandy loam, 0 to 2 percent slopes
LoB	Longrie sandy loam, 2 to 6 percent slopes
LsD	Longrie and Summerville sandy loams, 6 to 18 percent slopes
Ma	Made land
McB	Mancelona loamy sand, 0 to 6 percent slopes
McD	Mancelona loamy sand, 6 to 18 percent slopes
Mh	Marsh
MlB	Melita sand, 0 to 6 percent slopes
MnB	Menominee loamy sand, 0 to 6 percent slopes
MnD	Menominee loamy sand, 6 to 18 percent slopes
MuB	Munising sandy loam, 0 to 6 percent slopes
MuD	Munising sandy loam, 6 to 18 percent slopes
MuE	Munising sandy loam, 18 to 40 percent slopes
Nh	Nahma loam
NsA	Nester silt loam, 0 to 2 percent slopes
NsB	Nester silt loam, 2 to 6 percent slopes
OnA	Onaway fine sandy loam, 0 to 2 percent slopes
OnB	Onaway fine sandy loam, 2 to 6 percent slopes
OnC	Onaway fine sandy loam, 6 to 12 percent slopes

DELTA COUNTY AREA, MICHIGAN NO. 1

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

10

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 10

100

N

R. 24 W. | R. 23 W.

135 000 FEET

(Joins sheet 93)

1 540 000 FEET

T. 38 N. (Joins sheet 101)

2 Miles

10 000 Feet

Scale 1:24000

1 5000

(Joins sheet 99)

1 525 000 FEET

115 000 FEET

(Joins sheet 106)

DELTA COUNTY AREA, MICHIGAN NO. 100

This map is compiled on 1954 and 1970 aerial photographs by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks (and land division corners, if shown, are approximately positioned)

DELTA COUNTY AREA, MICHIGAN NO. 101
Compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

(Joins sheet 100)

140 000 FEET

1 540 000 FEET

R. 23 W. R. 22 W.

(Joins sheet 94)

T. 38 N.

(Joins sheet 102)

(Joins inset)

Portage Bay

Portage Point

Fishery Point

Ford River

Portage Creek

BAY

GREEN

(Joins lower left)

(Joins sheet 106)

1 524 000 FEET

1 519 000 FEET

145 000 FEET

165 000 FEET

1 525 000 FEET

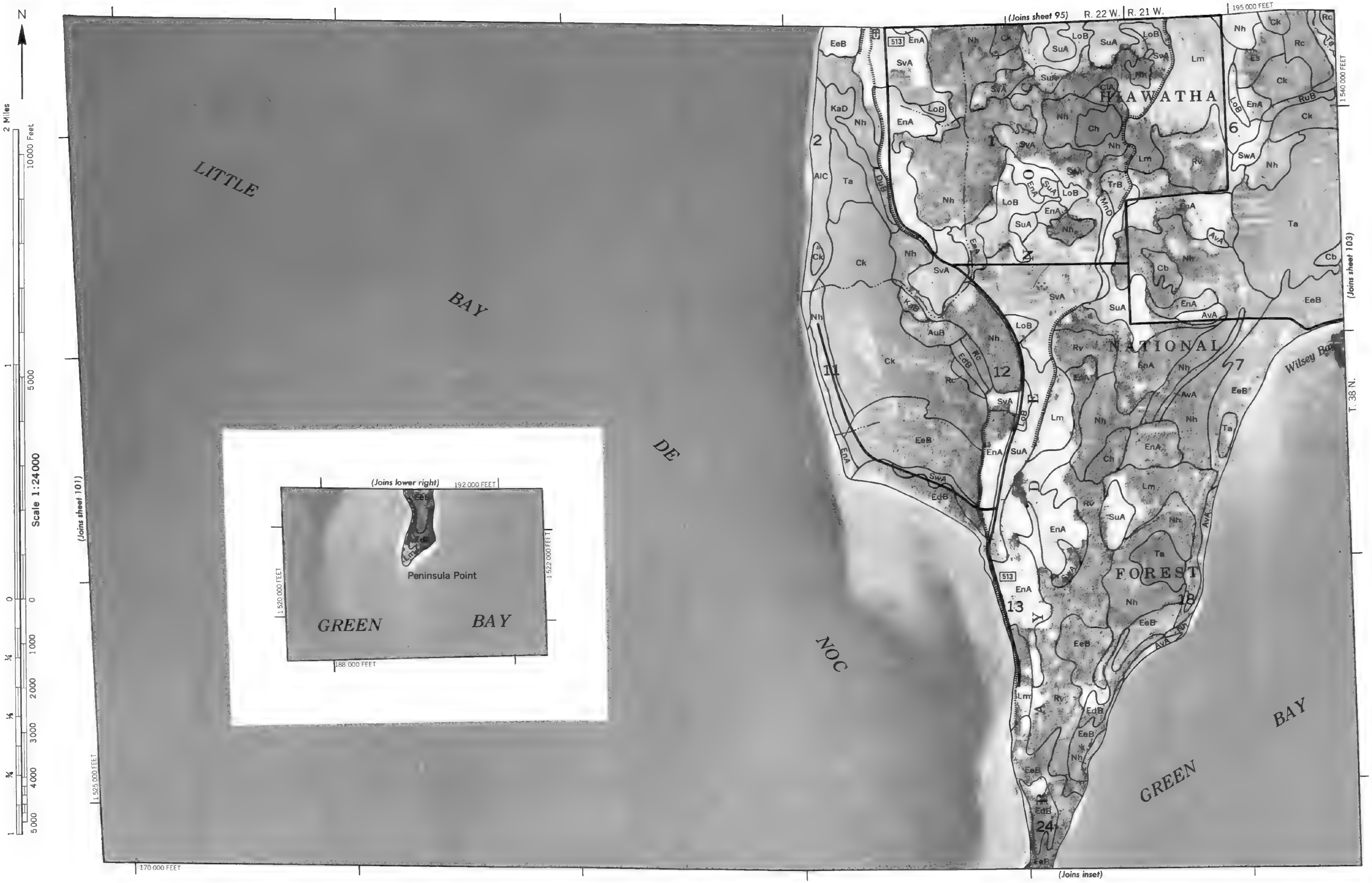
101

N

2 Miles

10000 Feet

Scale 1:24000



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 103

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

N

200 000 FEET

R. 21 W.

(Joins sheet 96)

1 540 000 FEET

T. 38 N.

(Joins sheet 102)

HIAWATHA NATIONAL FOREST

Chippewa Point

Wilsey Bay

Wilsey Creek

Wilsey Bay Point

BIG BAY DE NOC

GREEN BAY

225 000 FEET

239 000 FEET

R. 20 W.

1 551 000 FEET

T. 39 N.

Round Island

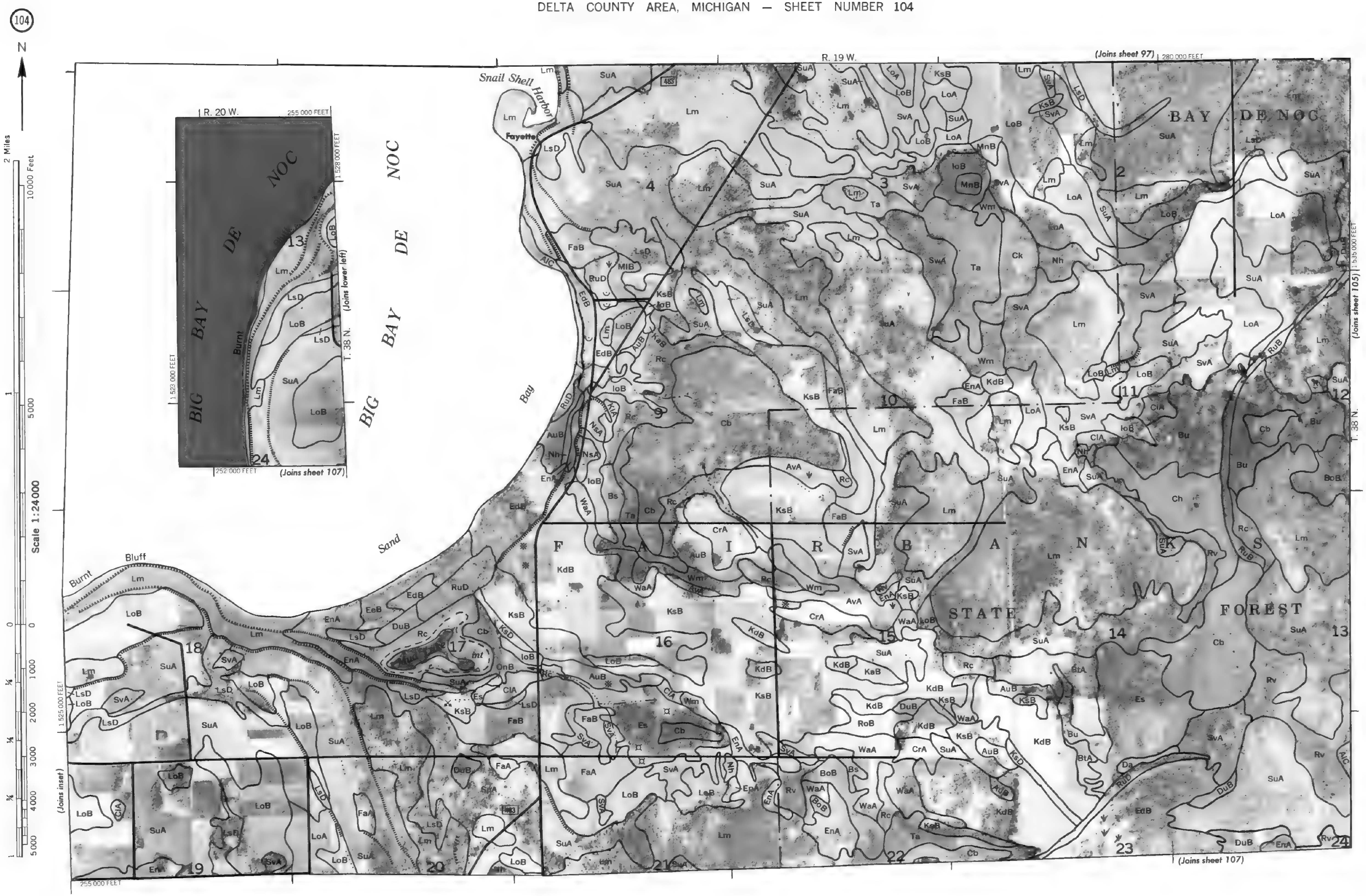
1 547 000 FEET

244 000 FEET

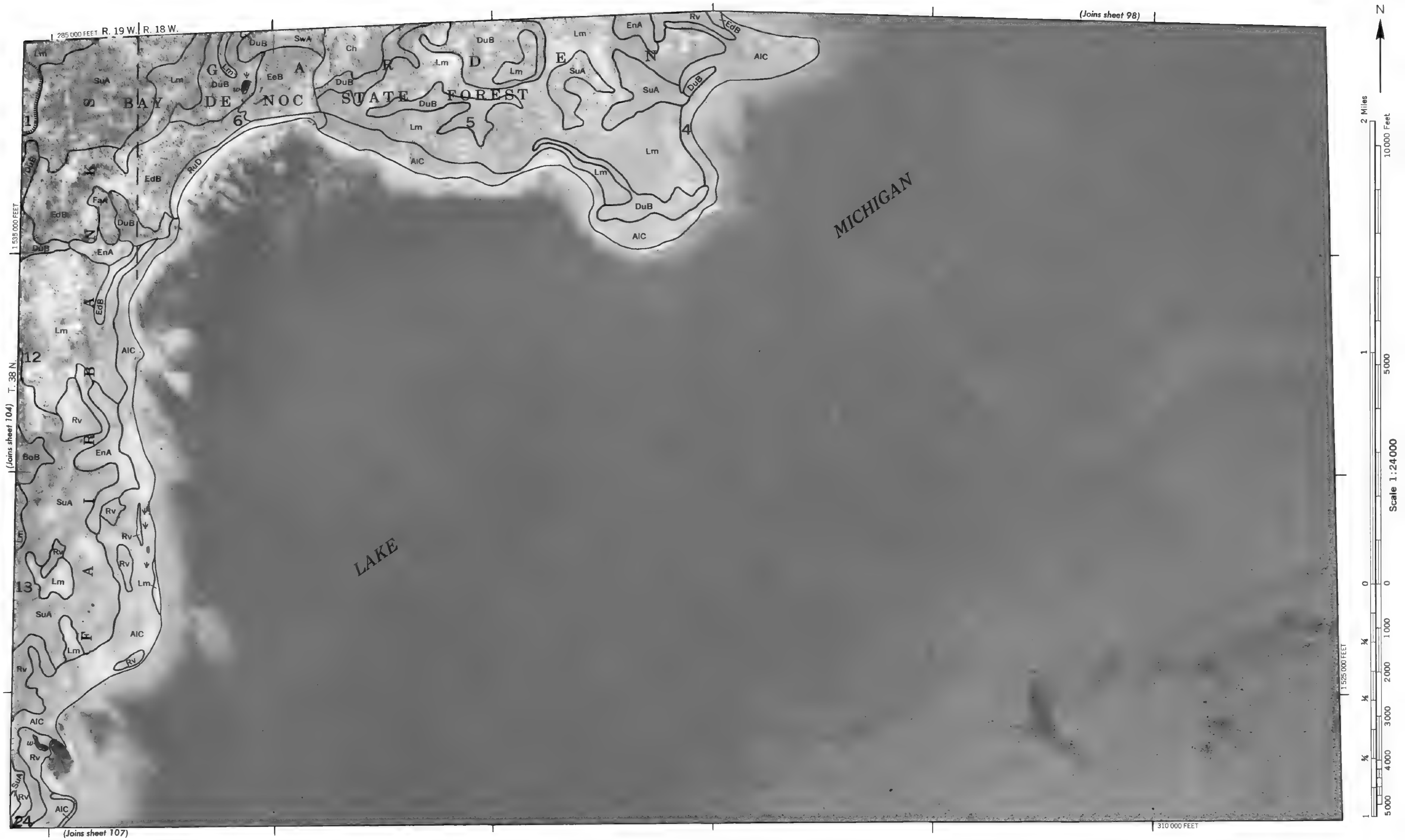
1 525 000 FEET

2 Miles 10000 Feet

Scale 1:24000



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned



DELTA COUNTY AREA, MICHIGAN NO. 105

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

2 Miles

10 000 Feet

Scale 1:24000

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 107

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

107

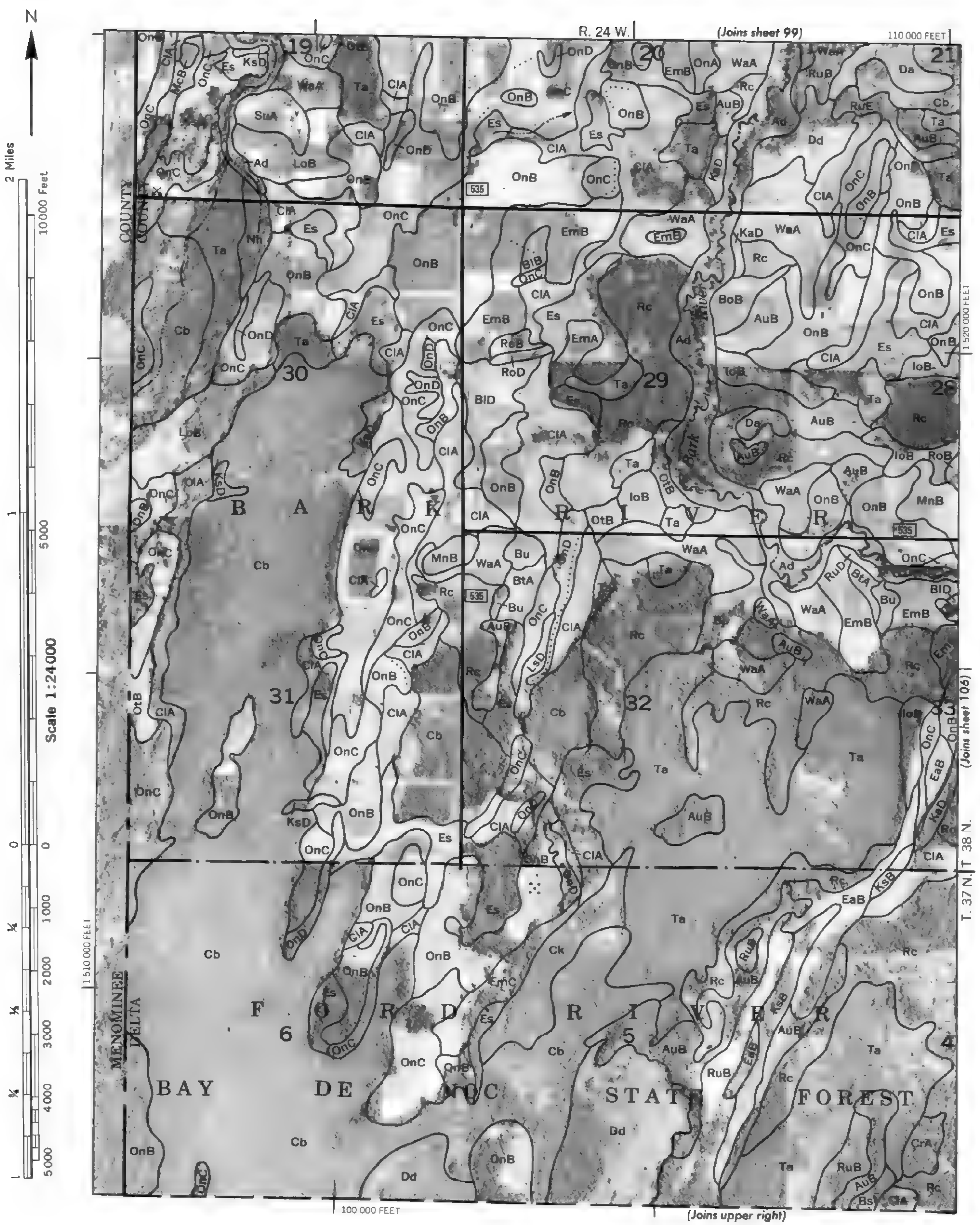
N

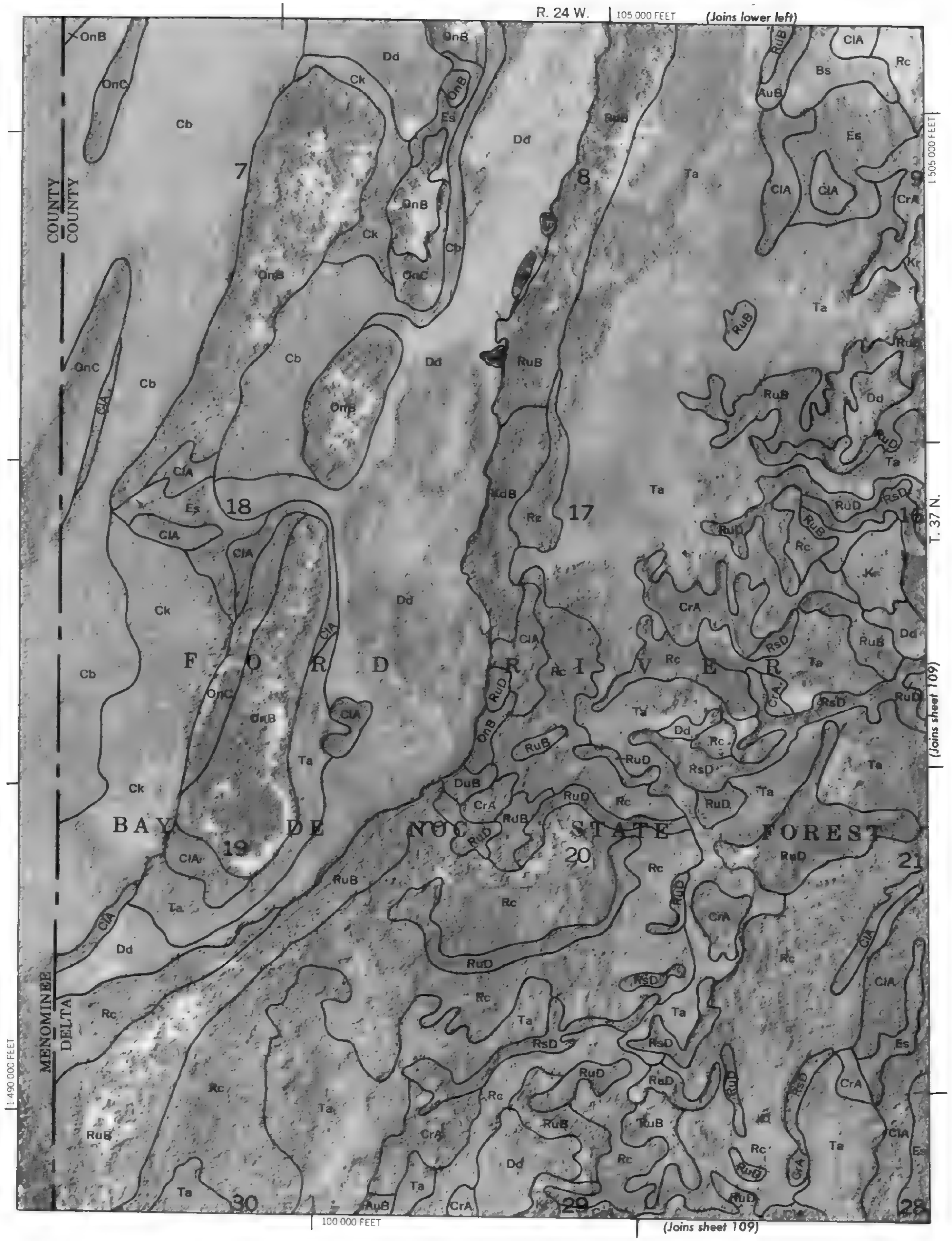
2 Miles

10000 Feet

Scale 1:24000

1 5000 0 1 000 2 000 3 000 4 000 5000

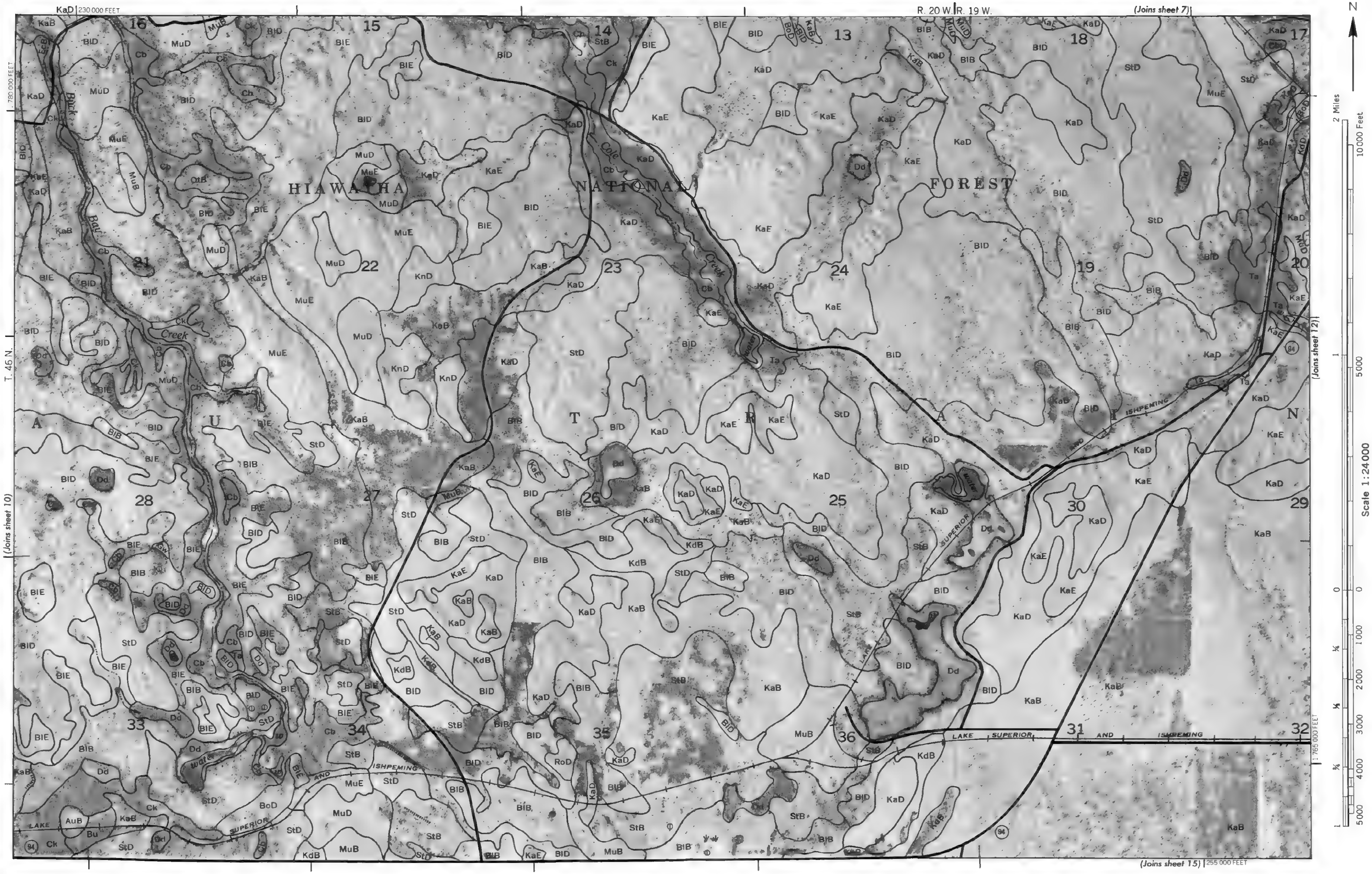




This map is compiled on 1954 and 1970 aerial photography by the U S Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 109

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1951 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

110

N

R. 20 W. | R. 19 W.

(Joins sheet 107) | 280 000 FEET

1 500 000 FEET

T. 37 N.

2 Miles

10000 Feet

Scale 1:24000

1 485 000 FEET

255 000 FEET

(Joins sheet 111)

F A I R B A N K S

BAY DE NOC STATE FOREST

GREEN BAY

LAKE MICHIGAN

9 Lm

EeB

10 RuD

Lm

11

Lm

14

Point Detour

8

AIC

7

SuA

Lm

EdB

12 Lm

Rocky Island

Little Summer Island

AIC

LoB

Lm

AIC

SuA

18

Lm

Gravel Point

21

Nh

AIC

SvA

AIC

SuA

DuB

Lm

Nh

Summer Island

Lm

Summer Harbor

DuB

AIC

Lm

SuA

28

27

This map is compiled on 1954 and 1970 aerial photographs by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 110

DELTA COUNTY AREA, MICHIGAN NO. 111

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

111

N

255 000 FEET

R. 19 W.

(Joins sheet 110)

1 480 000 FEET

T. 36 N. | T. 37 N.

BAY

MICHIGAN

28

27

26

SuA

Lm

Lm

Nh

AlC

Nh

SuA

SuA

LoB

AlC

Summer Island

FAIRBANKS

Lm

Cn

33

SuA

34

35

Lm

AlC

BAY DE NOC STATE FOREST

Lm

AlC

AlC

3

GREEN

LAKE

Poverty Island

9

FAIRBANKS

Lm

(Joins sheet 112)

1 470 000 FEET

280 000 FEET

2 Miles

1

0

10000 Feet

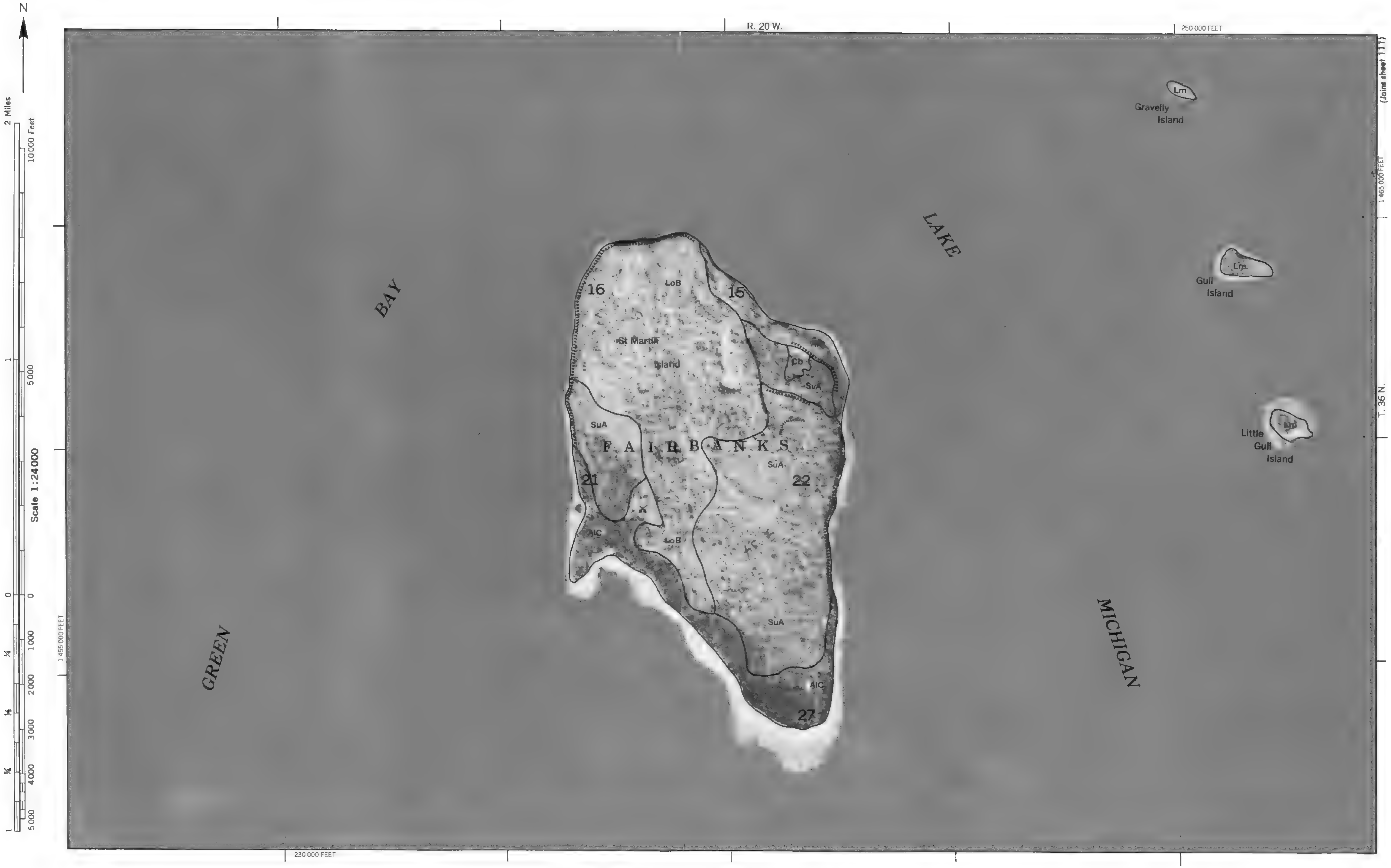
5000

0

Scale 1:24000

¼ ½ ¾ 1

5000 4000 3000 2000 1000 0



This map is compiled on 1954 and 1970 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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DELTA COUNTY AREA, MICHIGAN NO. 13

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and division corners, if shown, are approximately positioned

N

R. 18 W

T. 46 N.

(Joins sheet 9)

(Joins sheet 12)

(Joins sheet 17)

290 000 FEET

780 000 FEET

315 000 FEET

1 765 000 FEET

MUNISING

HIAWATHA NATIONAL FOREST

Wetmore Lake

North Branch Stutts Creek

Hickey Creek

Ishpeming and Manistique Railroad

Lake Superior

LIMIT OF SOIL SURVEY

NATIONAL FOREST BOUNDARY

QUARRY

ALGER COUNTY

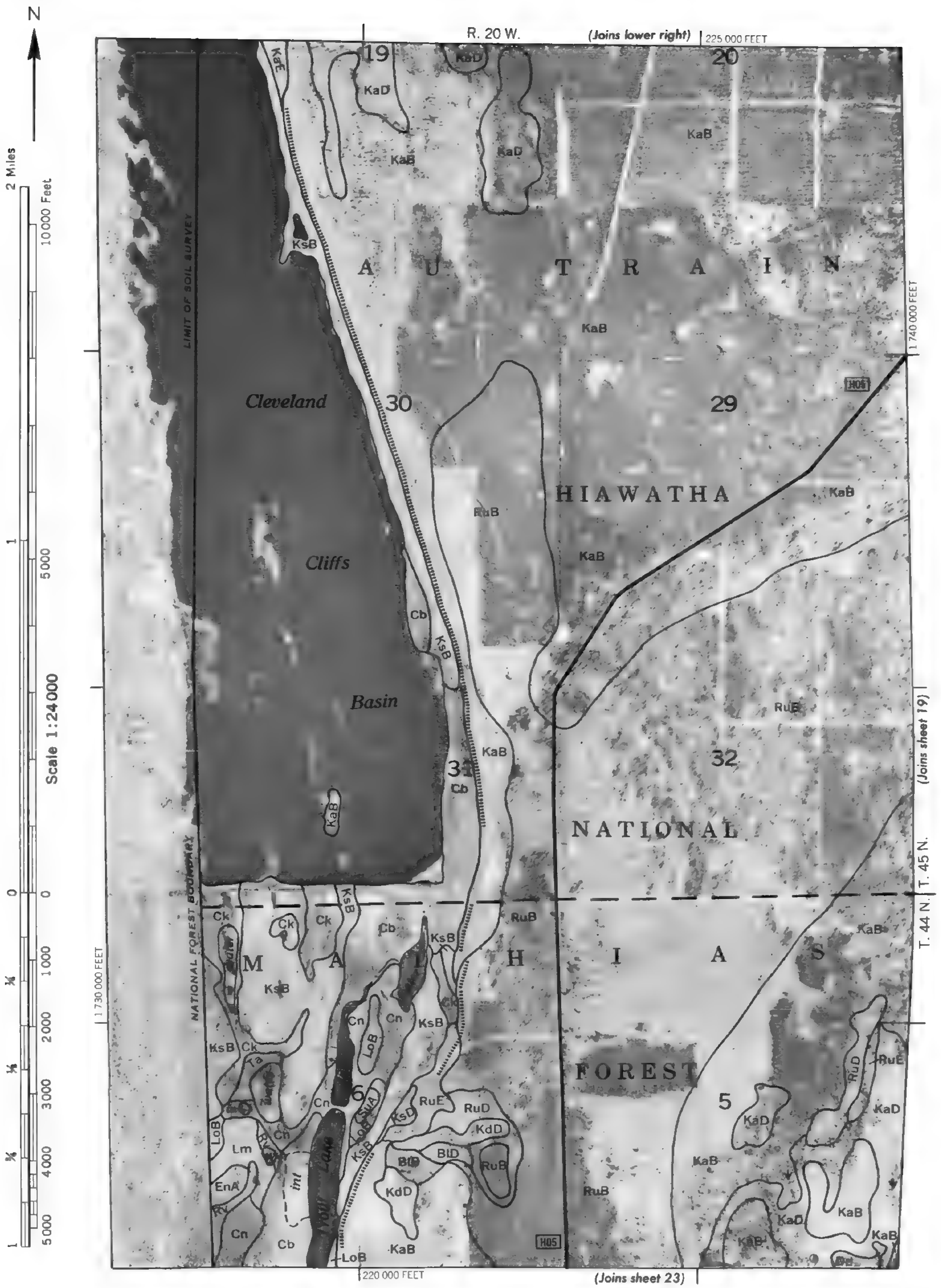
SCHOOLCRAFT COUNTY

2 Miles

10000 Feet

Scale 1:24000

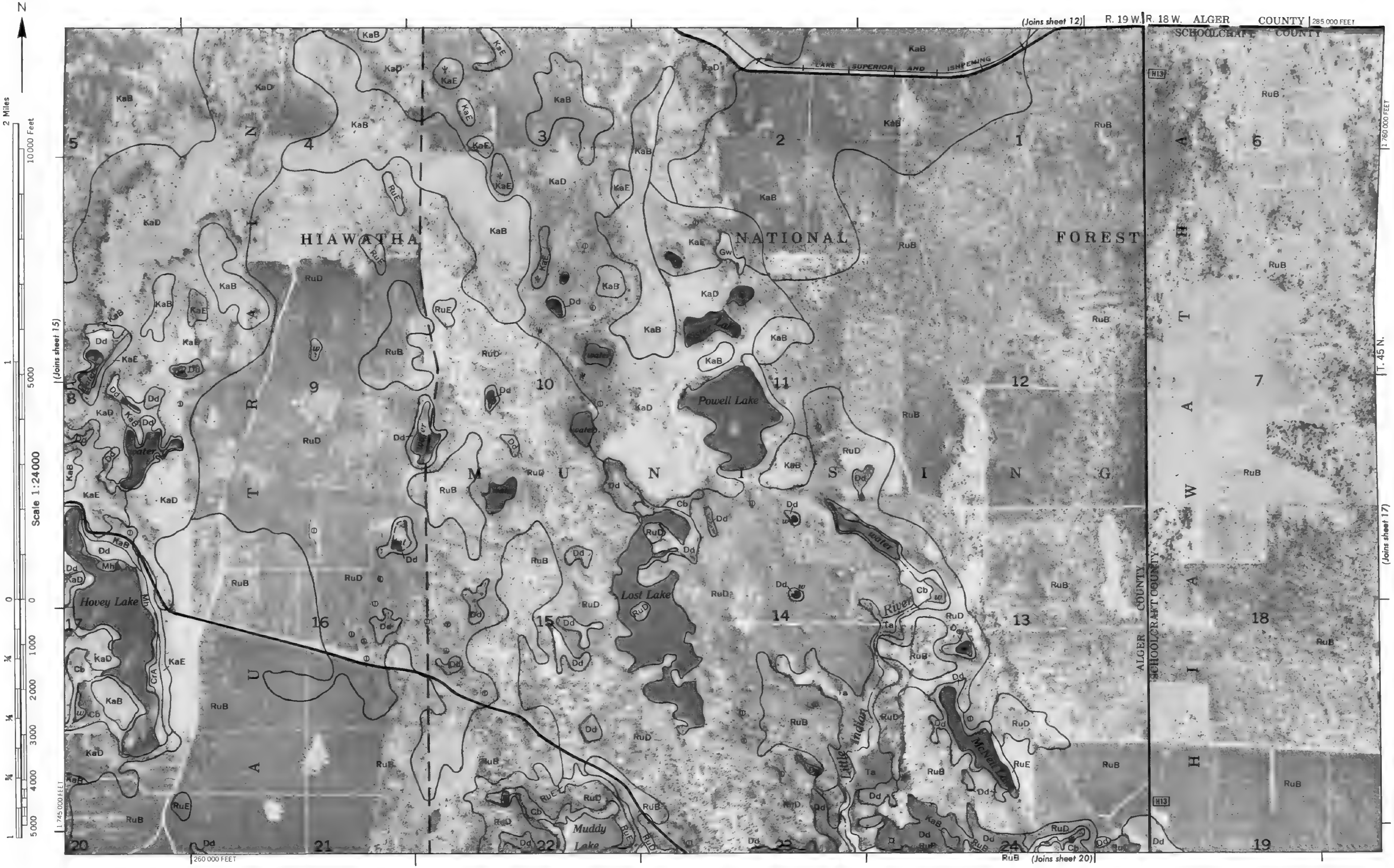
14



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 14

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1954 and 1970 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

17

DELTA COUNTY AREA, MICHIGAN NO. 17

This map is compiled on 1954 and 1970 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

290,000 FEET

ALGER COUNTY
SCHOOLCRAFT COUNTY

R. 18 W. R. 17 W.

(Joins sheet 13)

1,760,000 FEET

T. 45 N.

HIAWATHA NATIONAL FOREST

North Branch Stutts Creek

South Branch Stutts Creek

(Joins sheet 16)

(Joins sheet 18)

(Joins sheet 21)

1,745,000 FEET

315,000 FEET

N

2 M.les

10000 Feet

5000

1

Scale 1:24000

5000 4000 3000 2000 1000 0 0

18

N

NATIONAL FOREST BOUNDARY

ALGER COUNTY | SCHOOLCRAFT COUNTY

R. 17 W.

LIMIT OF SOIL SURVEY

340 000 FEET

1 760 000 FEET

LIMIT OF SOIL SURVEY

T. 45 N.

NATIONAL FOREST BOUNDARY

HIAWATHA NATIONAL FOREST

North Branch Manistique River

Hickey Creek

Star Creek

Stutts Creek

Lily Lake

(Joins sheet 17)

(Joins sheet 22)

320 000 FEET

745 000 FEET

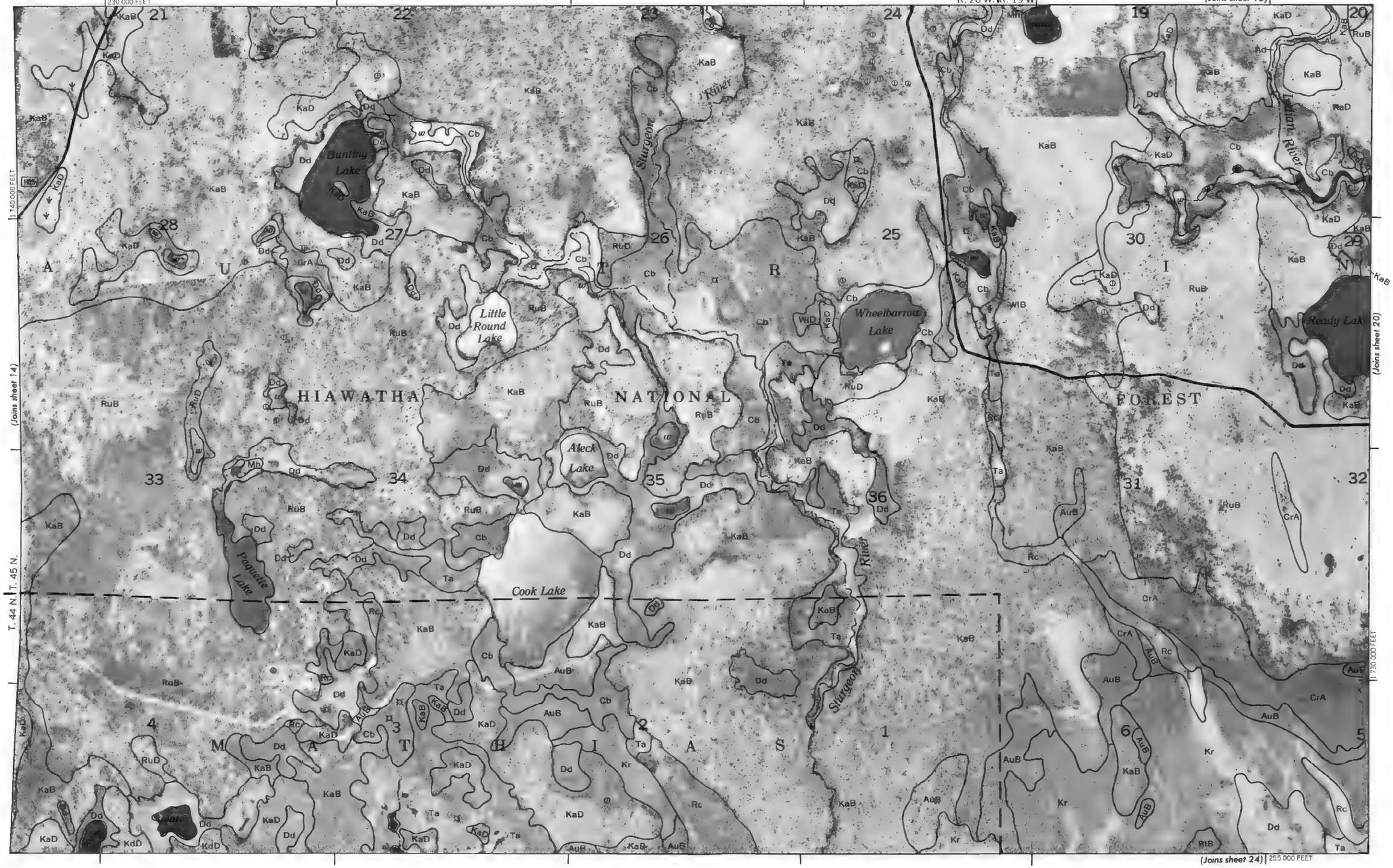
2 Miles

10000 Feet

Scale 1:24000

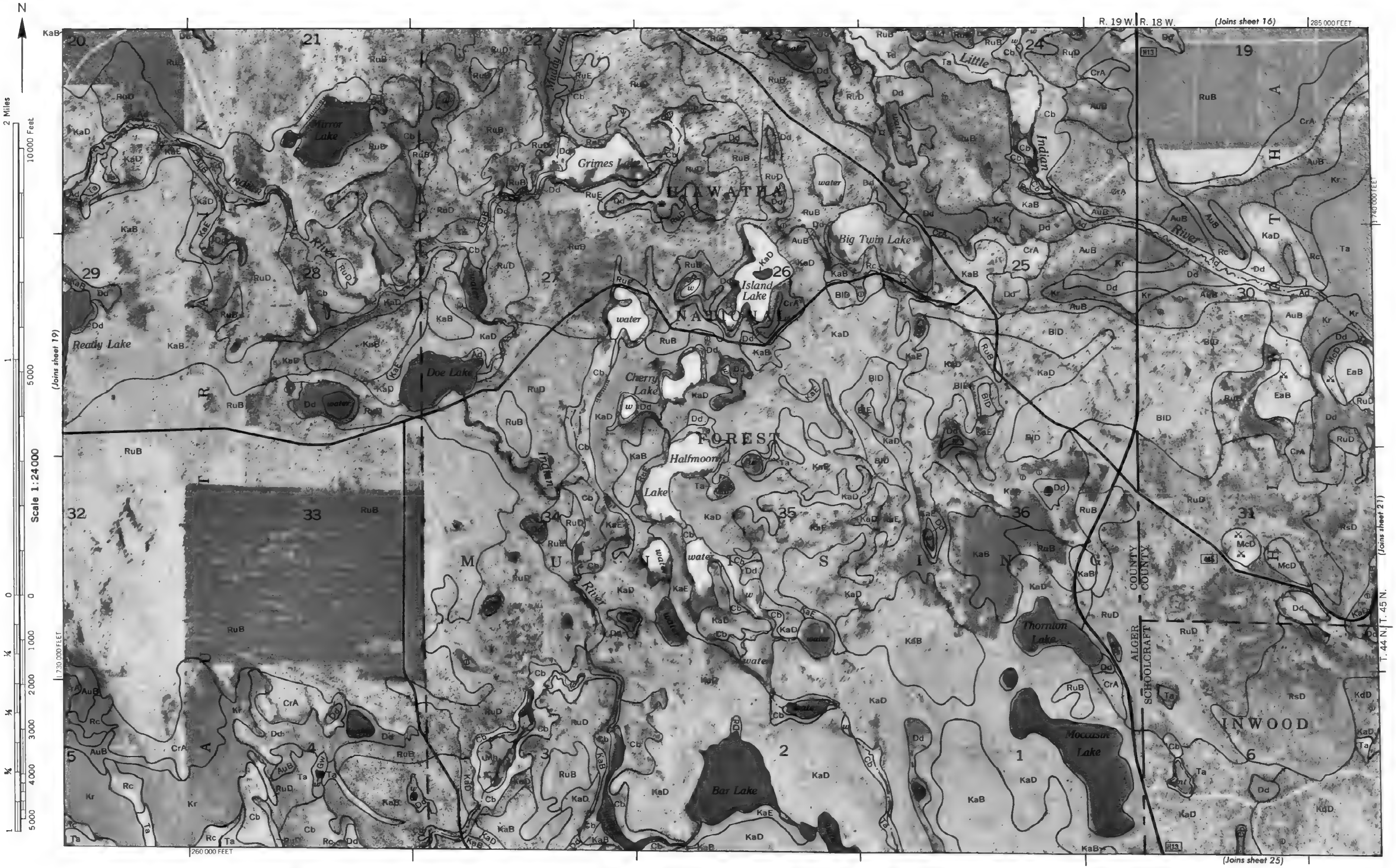
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 18

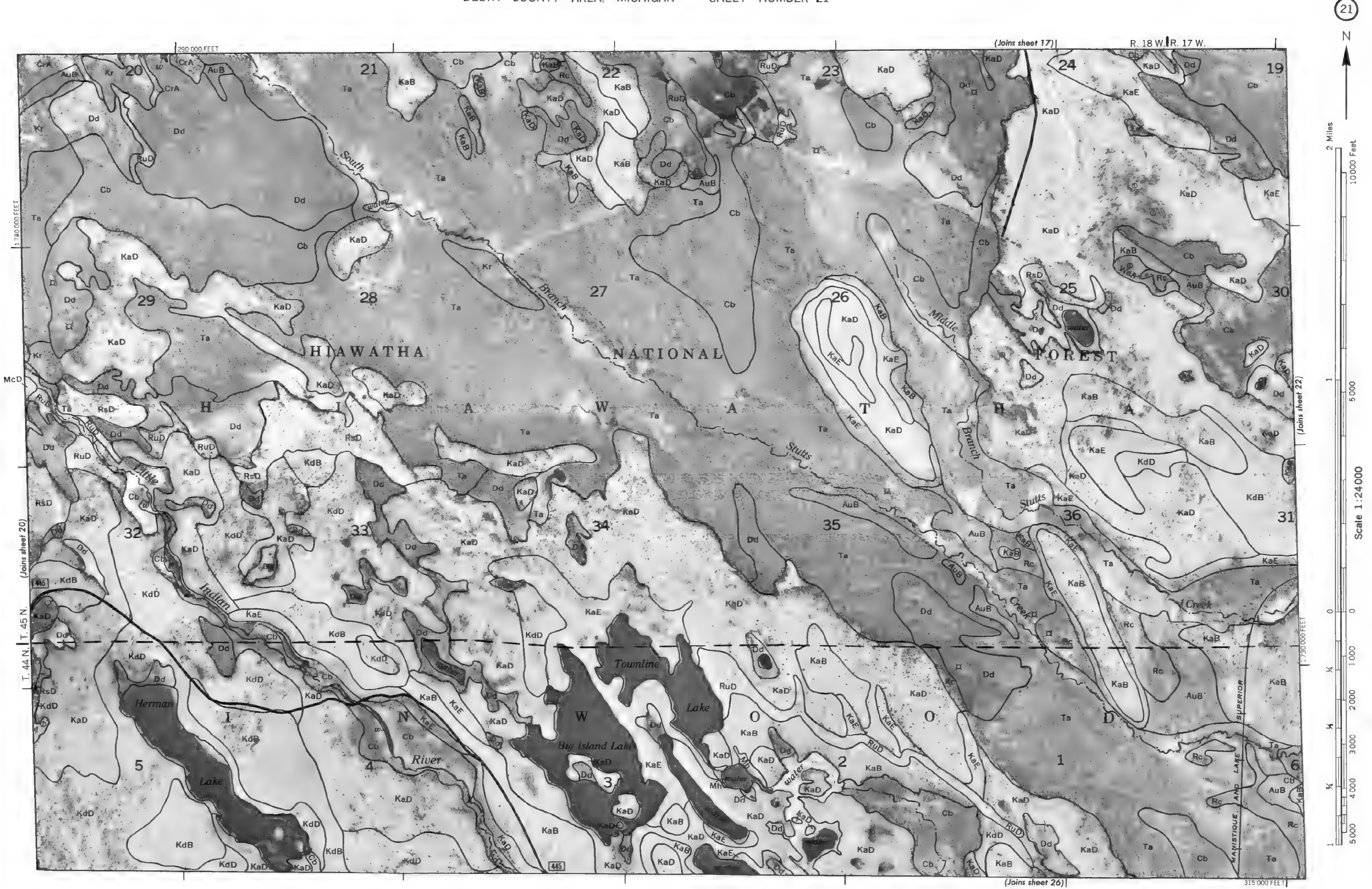


DELTA COUNTY AREA, MICHIGAN NO. 19
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

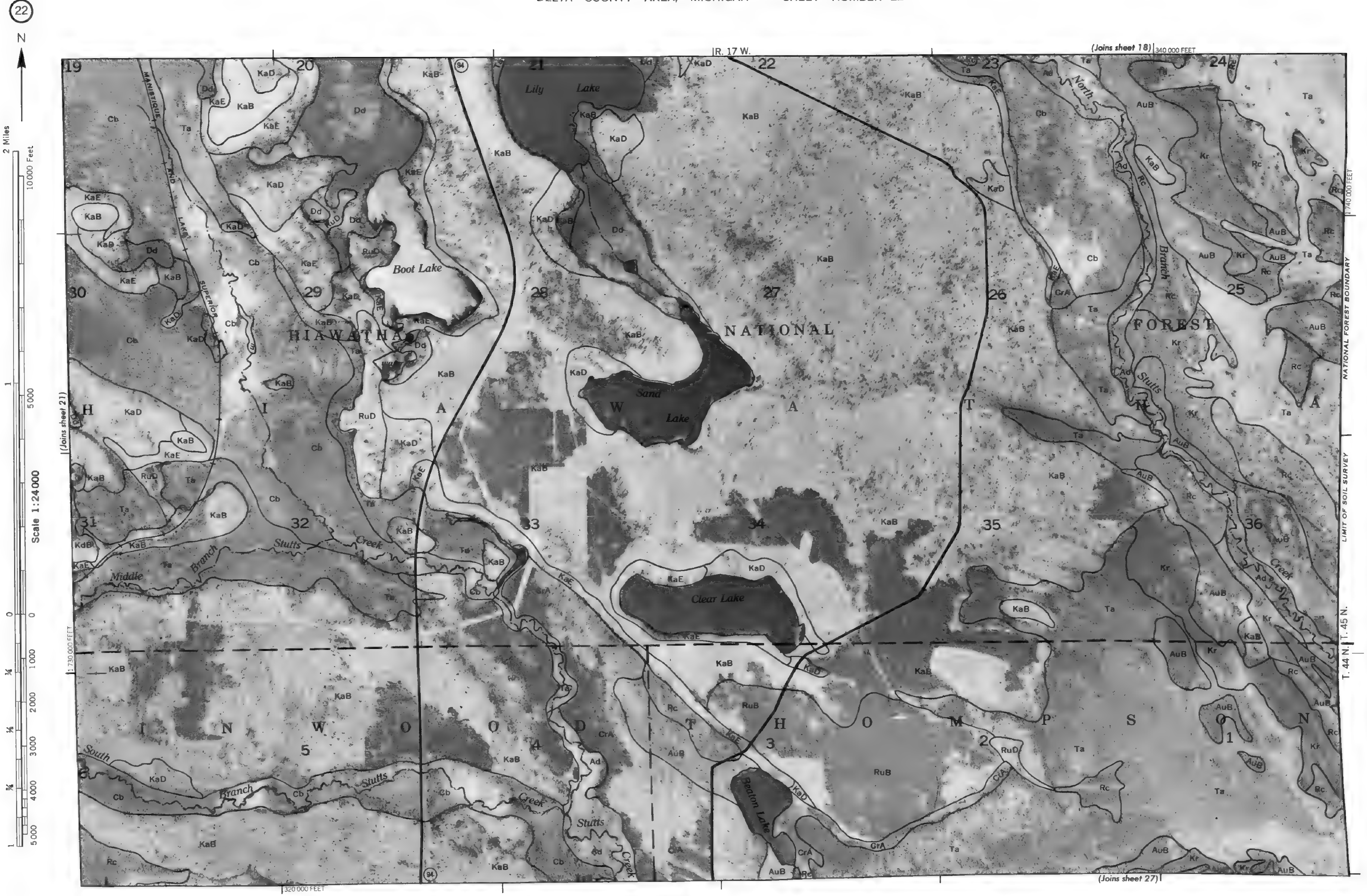


This map is compiled on 1974 and 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



DELTA COUNTY AREA, MICHIGAN, NO. 21

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

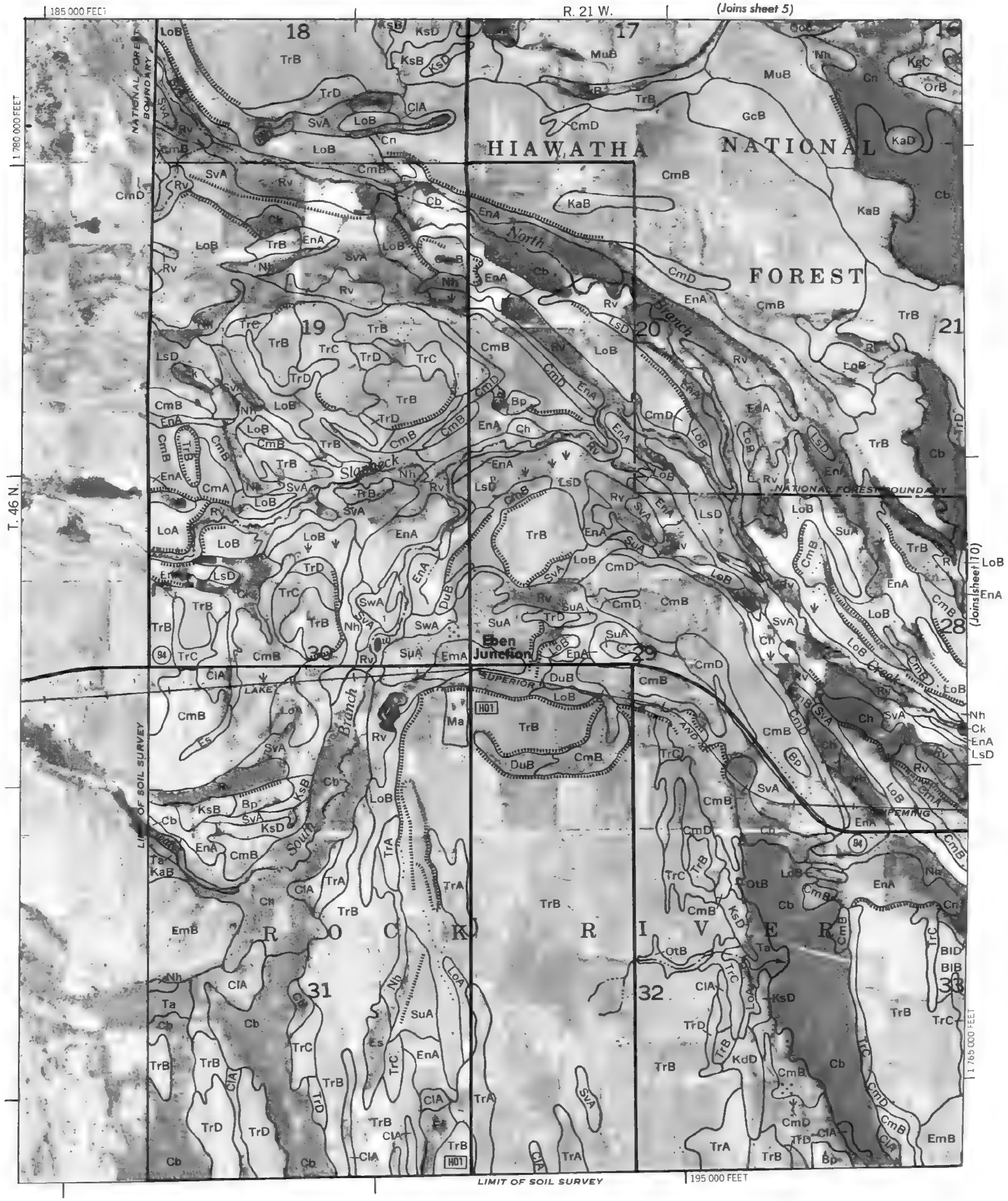


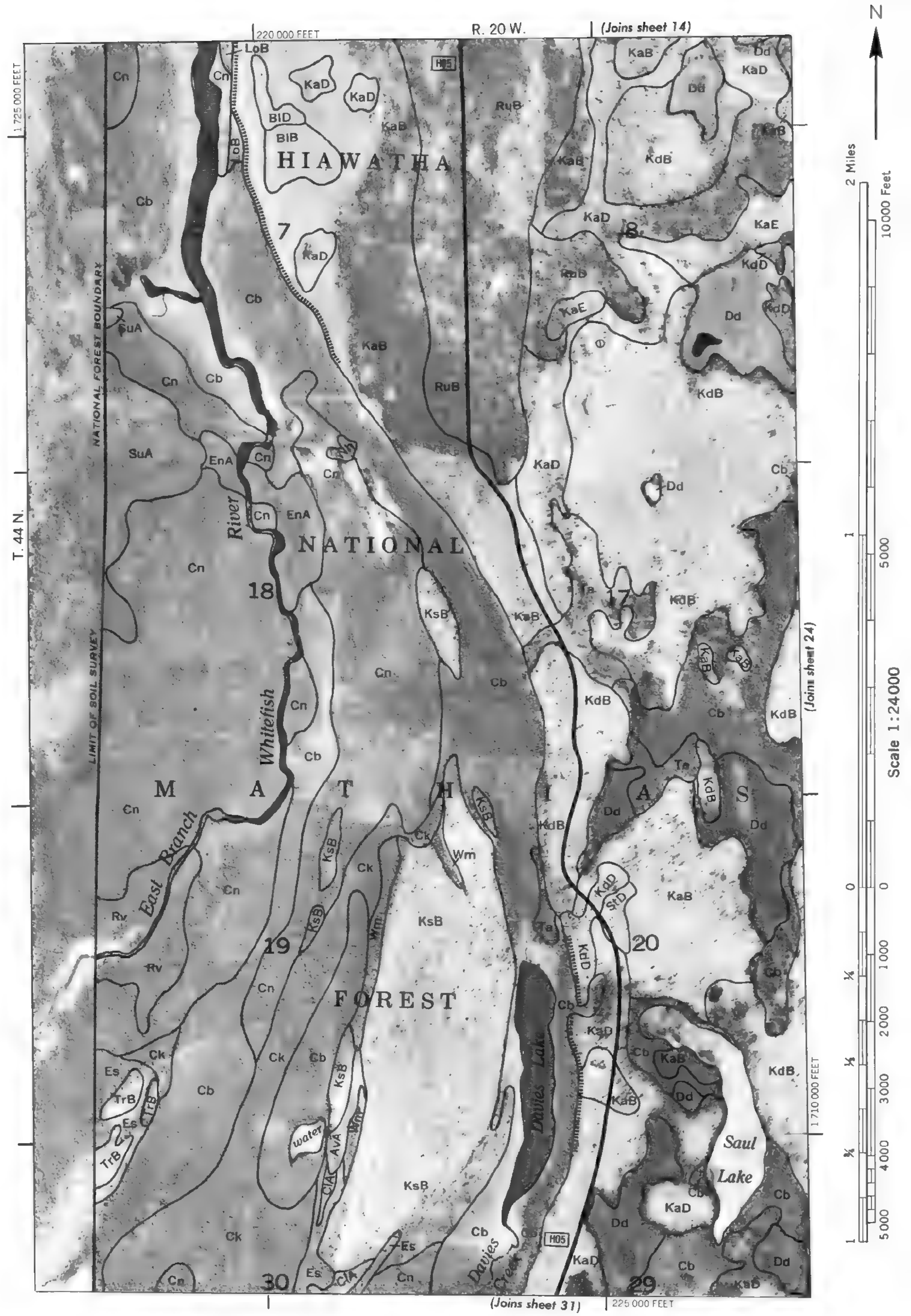
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 22

DELTA COUNTY AREA, MICHIGAN, NO. 23

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





DELTA COUNTY AREA, MICHIGAN — SHEET NUMBER 24

24

N

2 Miles

10000 Feet

Scale 1:24000

R. 20 W. R. 19 W.

(Joins sheet 19)

255 000 FEET

1 725 000 FEET

T. 44 N.

(Joins sheet 23)

1 710 000 FEET

230 000 FEET

(Joins sheet 25)

(Joins sheet 32)

HIAWATHA NATIONAL FOREST

Sturgeon River

Sturgeon River

Lake Stella

Cranberry Lake

Dam Lake

Stowfoot Lake

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 24

DELTA COUNTY AREA, MICHIGAN NO. 25

260 000 FEET

1 725 000 FEET

R. 19 W. R. 18 W. (Joins sheet 20)

T. 44 N.

HIAWATHA NATIONAL FOREST

Town Lake
Petes Lake
Fish Lake
Bald Lake
McKeever Lake
Tie Lake
Man Lake
McComb Lake
Straits Lake
Indian River
Camp R
Rock Creek
SCHOOLCRAFT COUNTY
ALGER COUNTY

(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 33)

1 710 000 FEET

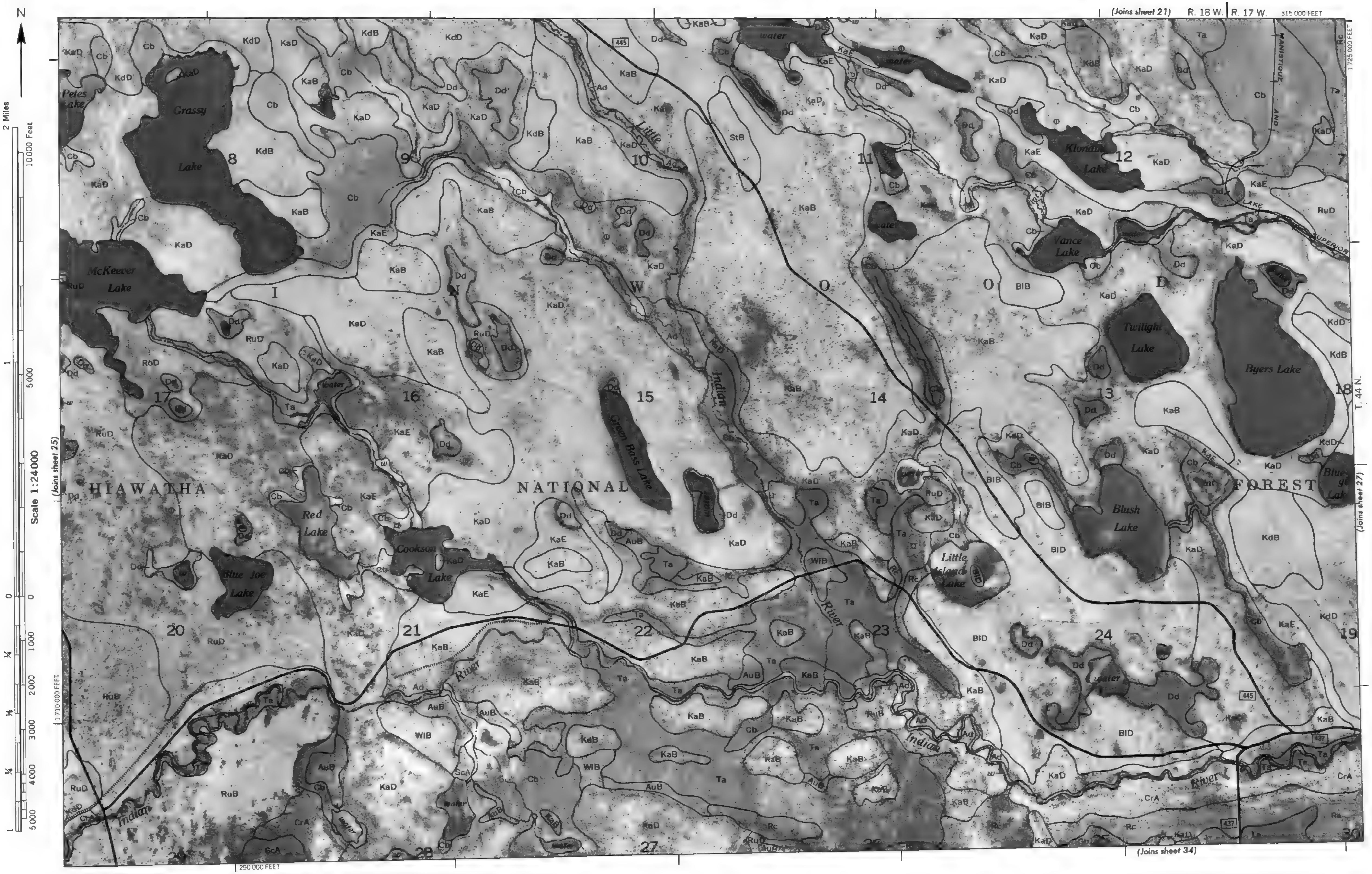
285 000 FEET

N

2 Miles

10000 Feet

Scale 1:24000



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 27

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

320 000 FEET

1 795 000 FEET

R. 17 W.

(Joins sheet 22)

T. 44 N.

(Joins sheet 25)

(Joins sheet 35)

1 340 000 FEET

1 710 000 FEET

T H O M P S O N

HIAWATHA NATIONAL FOREST

Colwell Lake

Crooked Lake

Pear Lake

Bluegill Lake

Steuben Lake

East Lake

Stutts Creek

Indian River

Steuben

LIMIT OF SOIL SURVEY

NATIONAL FOREST BOUNDARY

N

2 Miles

10 000 Feet

Scale 1:24000

28

N

Scale 1:24000

2 Miles 10000 Feet 1 5000

140 000 FEET

110 000 FEET

90 000 FEET

115 000 FEET

1 637 000 FEET

1 640 000 FEET

1 695 000 FEET

1 705 000 FEET

MARQUETTE COUNTY

DELTA COUNTY

MENOMINEE CO.

R. 24 W.

R. 23 W.

T. 41 N.

T. 43 N.

CHICAGO AND LAKE SUPERIOR

CHICAGO AND NORTH WESTERN

Hunters Brook

Rapid River

BAY DE NOC STATE FOREST

(Joins sheet 52)

(Joins sheet 60)

(Joins sheet 29)

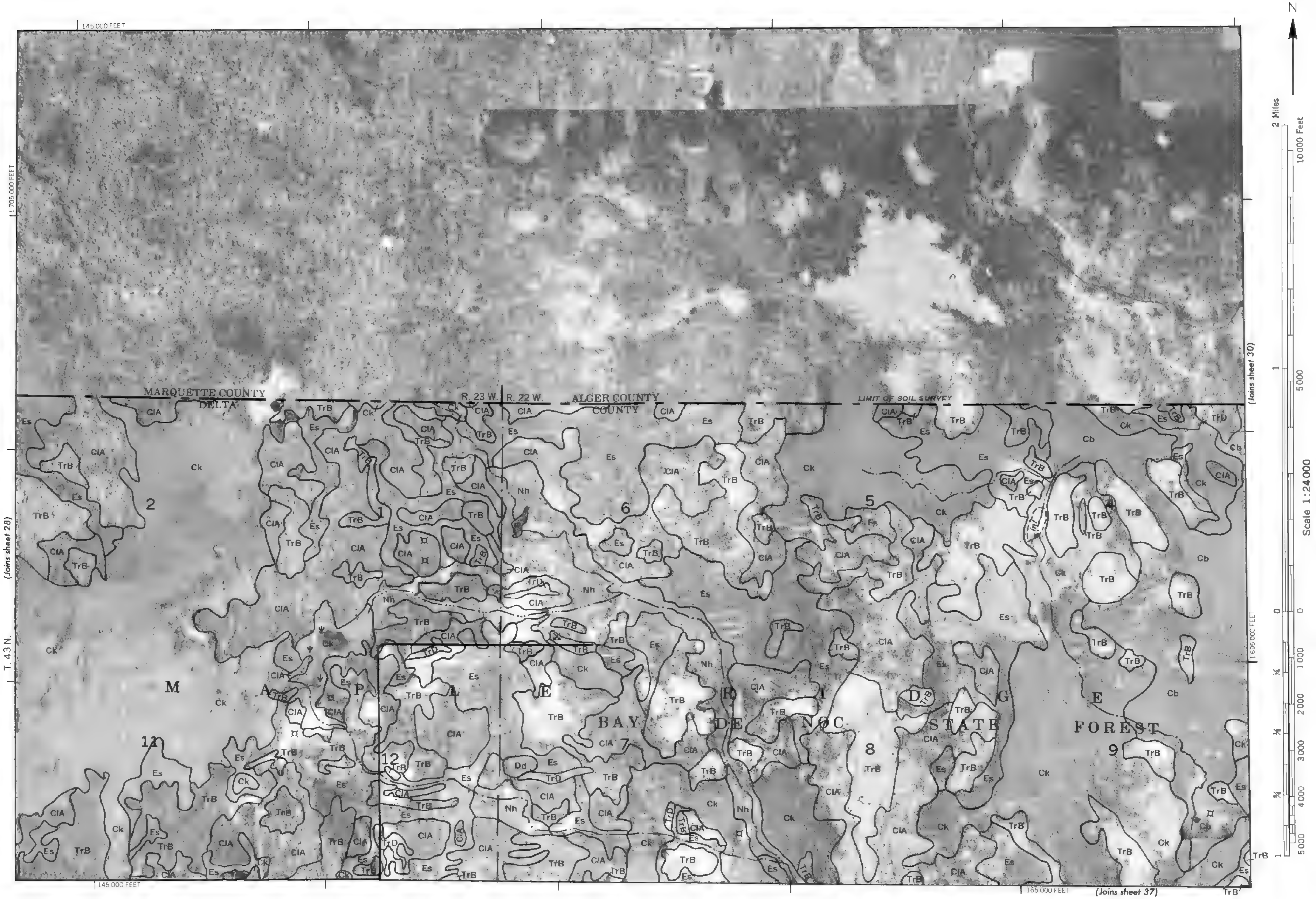
(Joins sheet 36)

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land corner corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 28

DELTA COUNTY AREA, MICHIGAN NO. 29

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



DELTA COUNTY AREA, MICHIGAN NO. 3

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and division corners if shown are approximately positioned

230 000 FEET

R. 20 W. R. 19 W.

1 815 000 FEET

T. 47 N.

SUPERIOR LAKE

SUPERIOR

LAKE

HIAWATHA NATIONAL FOREST

Hanson Creek

Turner Lake

(Joins sheet 2)

(Joins sheet 7) 255 000 FEET

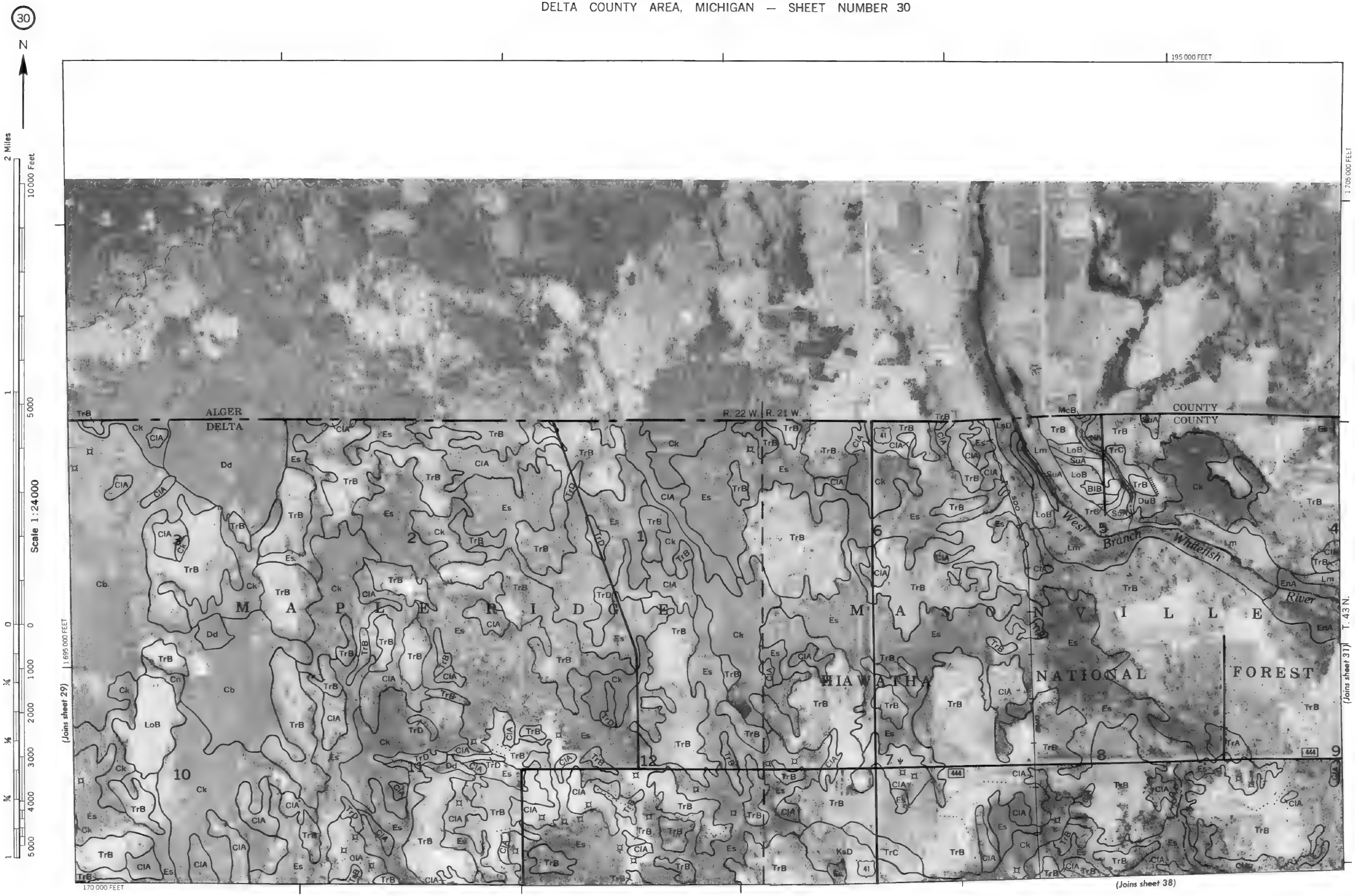
1 800 000 FEET

N

2 Miles

10000 Feet

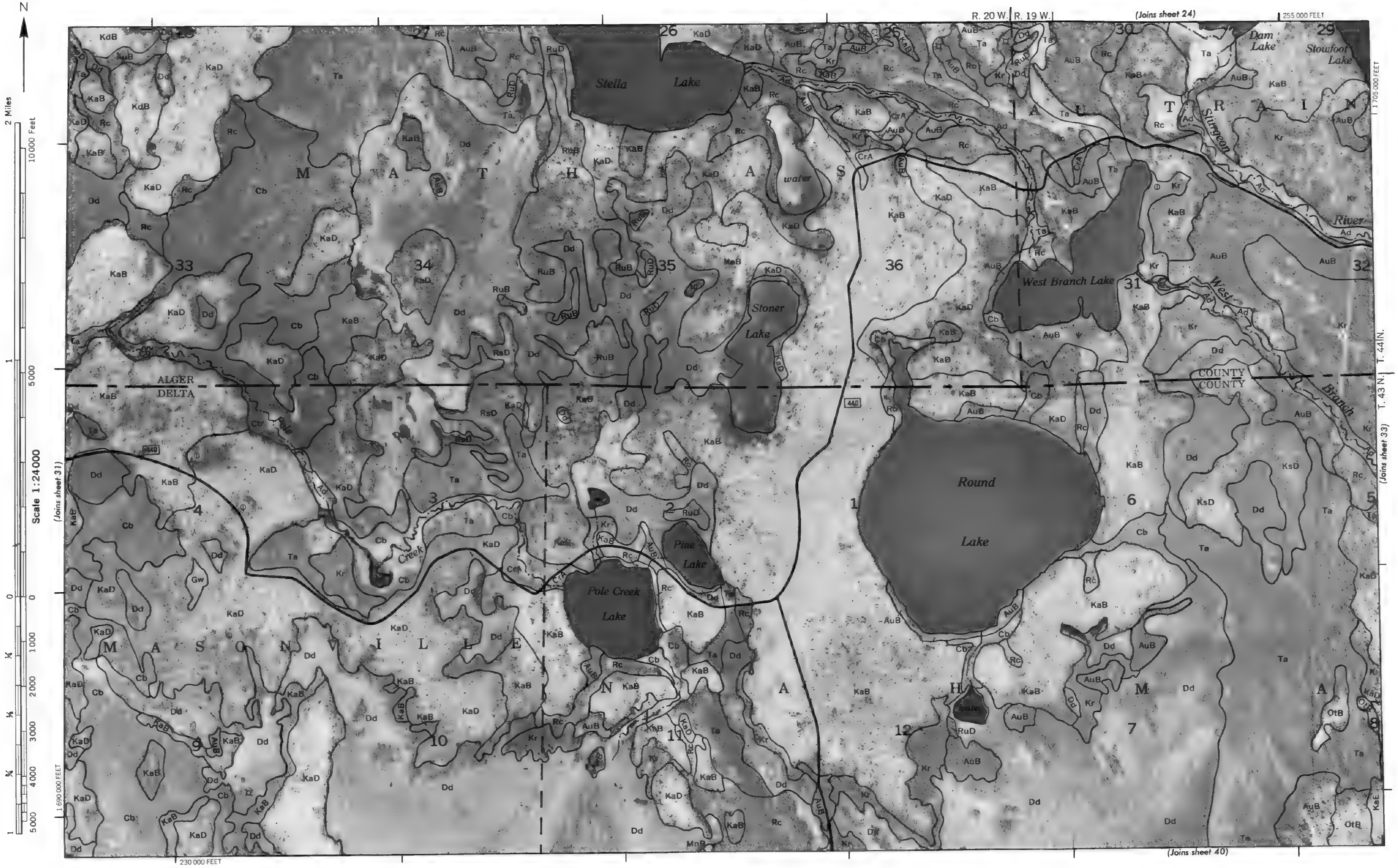
Scale 1:24000



This map is compiled on 1958 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

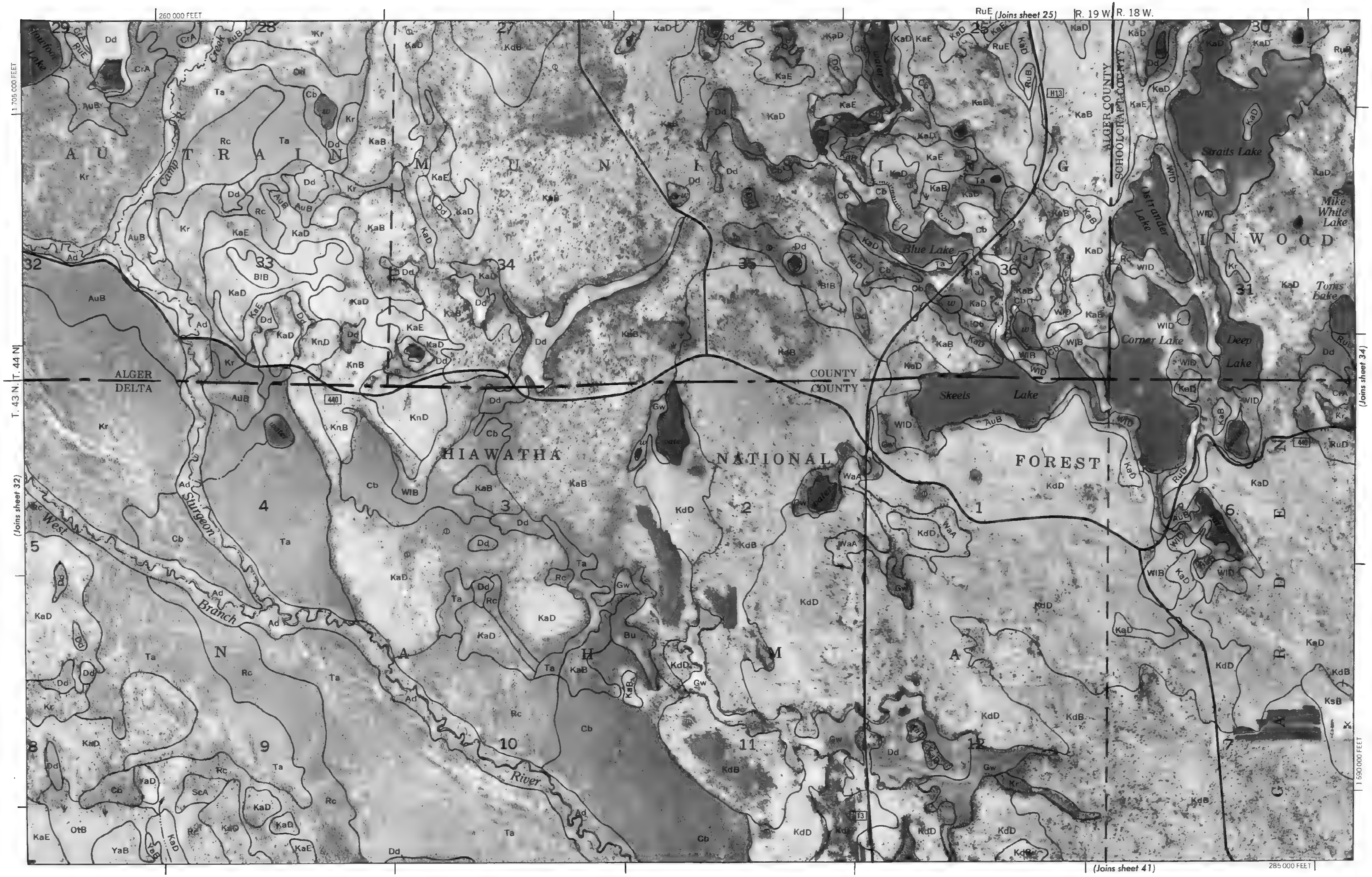
DELTA COUNTY AREA, MICHIGAN NO. 31
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN — SHEET NUMBER 32



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

(33)



N

2 Miles
10000 Feet
1
5000
0
0
1000
2000
3000
4000
5000
Scale 1:24000

DELTA COUNTY AREA, MICHIGAN NO. 33

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

34

N

2 Miles 10000 Feet

1 5000

Scale 1:24000

0 0 1000 2000 3000 4000 5000

(Joins sheet 26)

R. 18 W. R. 17 W.

315 000 FEET

1 705 000 FEET

T. 44 N.

T. 43 N.

(Joins sheet 33)

(Joins sheet 35)

(Joins sheet 42)

1 690 000 FEET

290 000 FEET

HIAWATHA NATIONAL FOREST

SCHOOLCRAFT COUNTY

DELTA COUNTY

Verdant Lake

Ironjaw Lake

Nineteen Lake

Triangle Lake

Swan Lake

Toms Lake

The White Lake

Mowe Lake

Minerva Lake

Poole Lake

Hughes Lake

Leg Lake

Bas Lake

This map is compiled on 1934 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid of ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 34

DELTA COUNTY AREA, MICHIGAN NO. 35
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

35

N

320 000

R. 17 W.

(Joins sheet 27)

1 705 000 FEET

T. 44 N.

T. 43 N.

(Joins sheet 34)

HIAWATHA NATIONAL FOREST

MANISTIQUE ARM LAKE

LIMIT OF SOIL SURVEY

NATIONAL FOREST BOUNDARY

T H O M P S O N

I N W O O D

East Lake

Bass Lake

Little Bass Lake

Hughes Lake

Three Island Lake

Minerva Lake

Murphy Lake

Indian River

(Joins sheet 43)

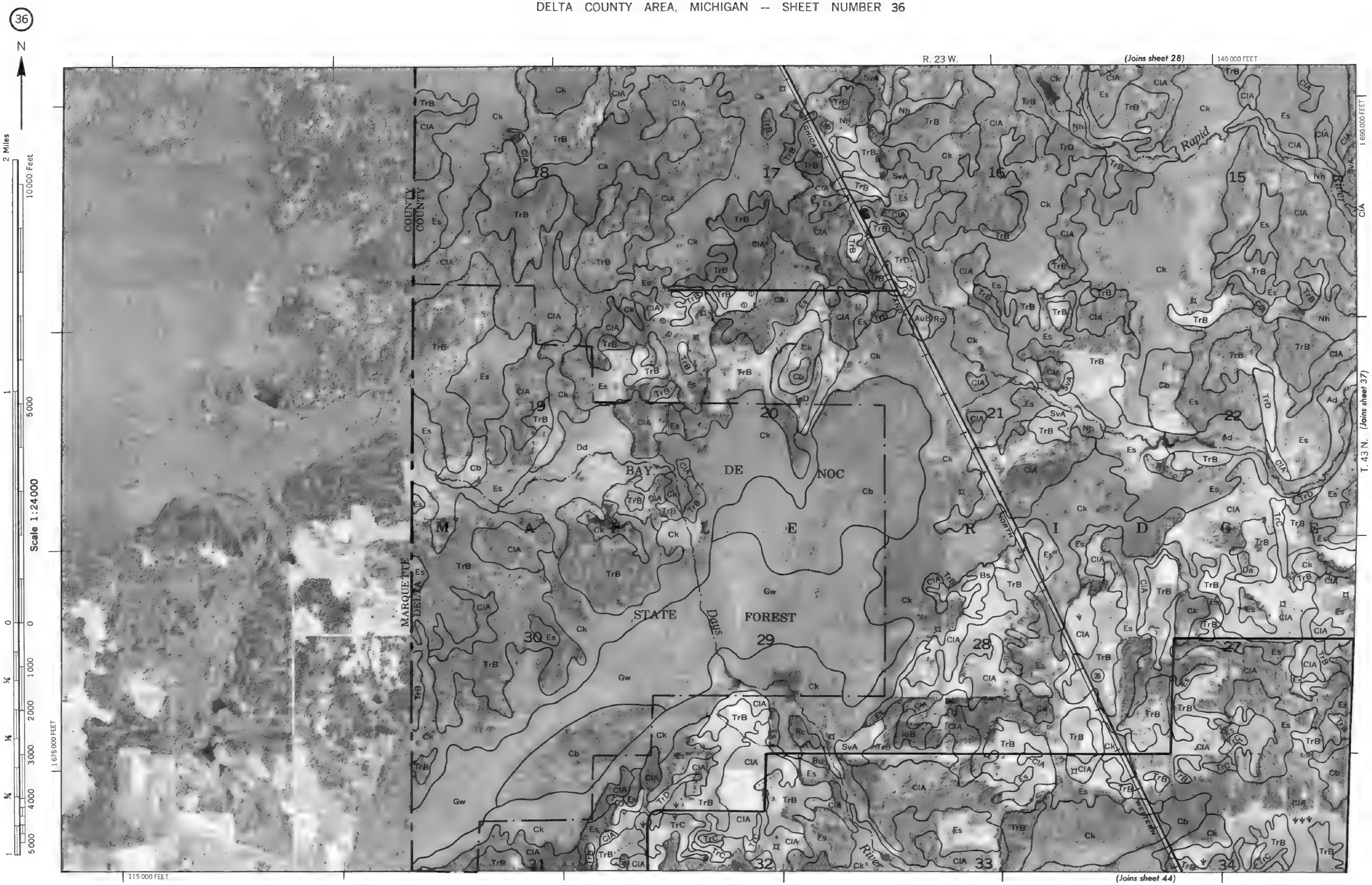
340 000 FEET

1 690 000 FEET

2 Miles

10 000 Feet

Scale 1:24000



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 37

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

145 000 FEET

R. 23 W. R. 22 W.

(Joins sheet 29)

1 690 000 FEET

T. 43 N.

(Joins sheet 36)

(Joins sheet 38)

1 675 000 FEET

(Joins sheet 45)

165 000 FEET

N

2 Miles

10 000 Feet

Scale 1:24000

38

N

2 Miles 10000 Feet

1 5000

Scale 1:24000

1 5000 4000 ¾ 3000 ½ 2000 1000 ¼ 0 0

1 675 000 FEET

170 000 FEET

195 000 FEET

1 685 000 FEET

T. 43 N.

R. 22 W.

R. 21 W.

(Joins sheet 30)

(Joins sheet 37)

(Joins sheet 39)

(Joins sheet 46)

BAY DE NOC

MAPLE RIDGE STATE FOREST

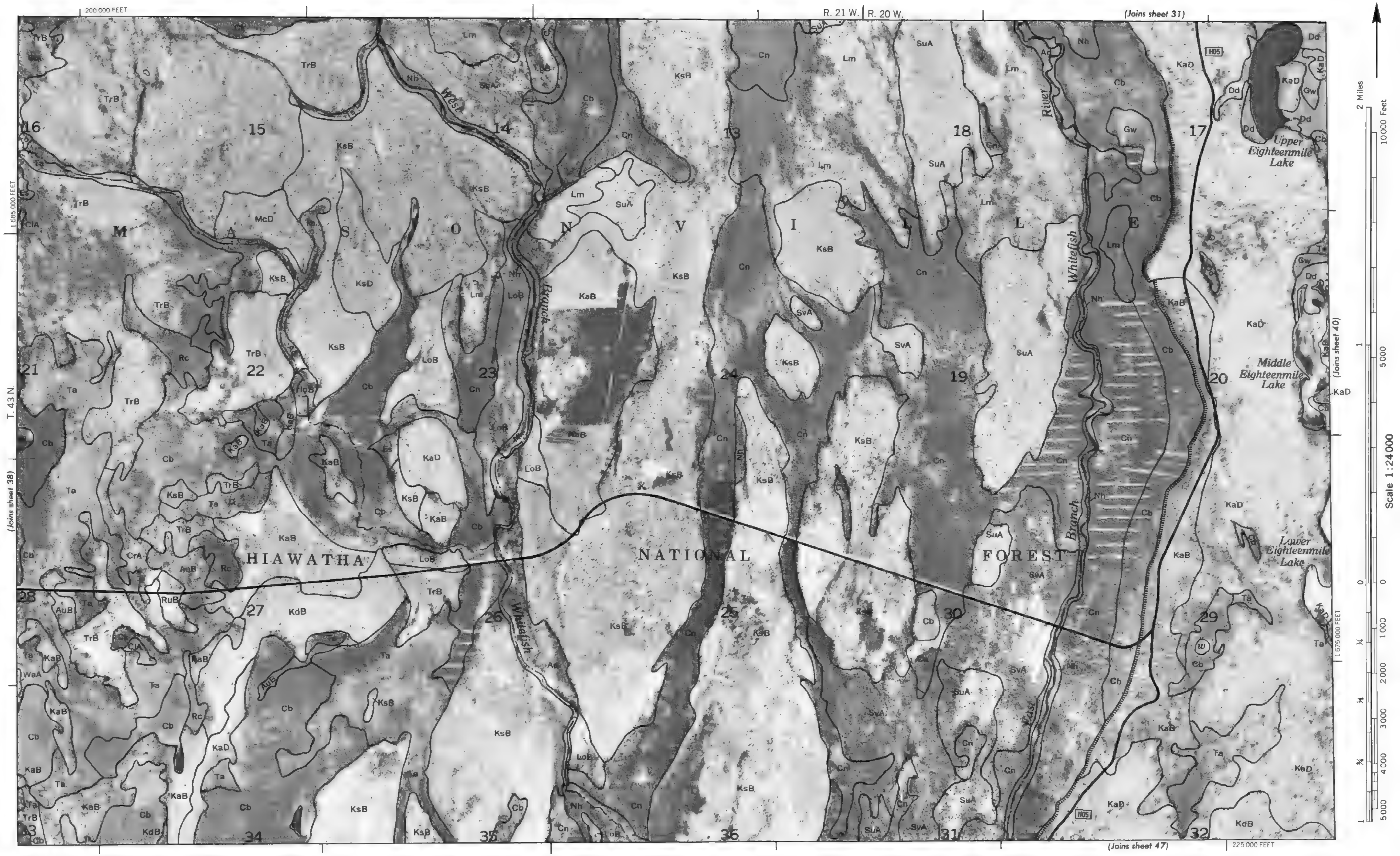
MASONVILLE HIAWATHA NATIONAL FOREST

Rapid River

15 14 13 16 22 23 24 21 27 26 25 30 29 28 34 35 36 31 32 33

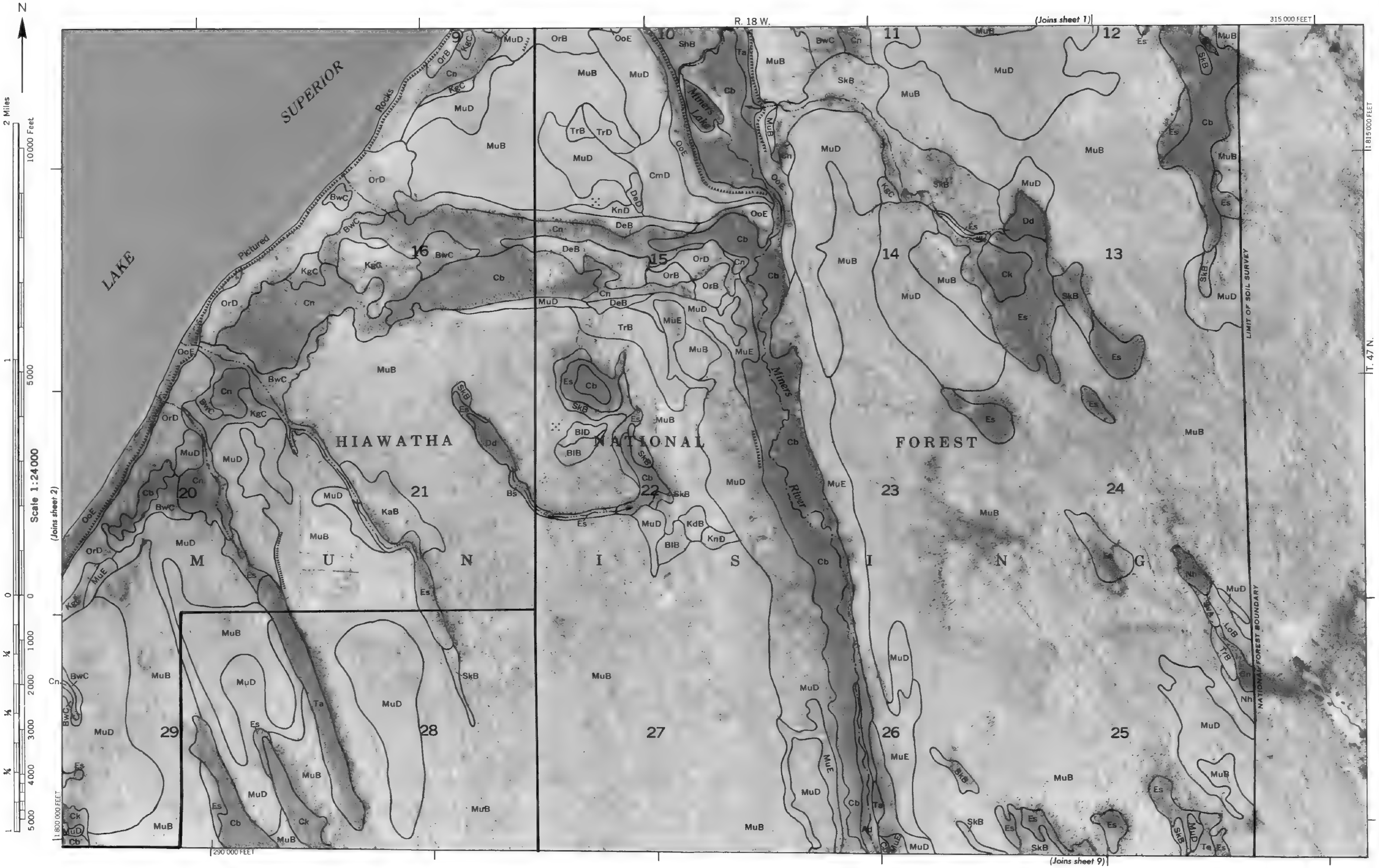
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 38

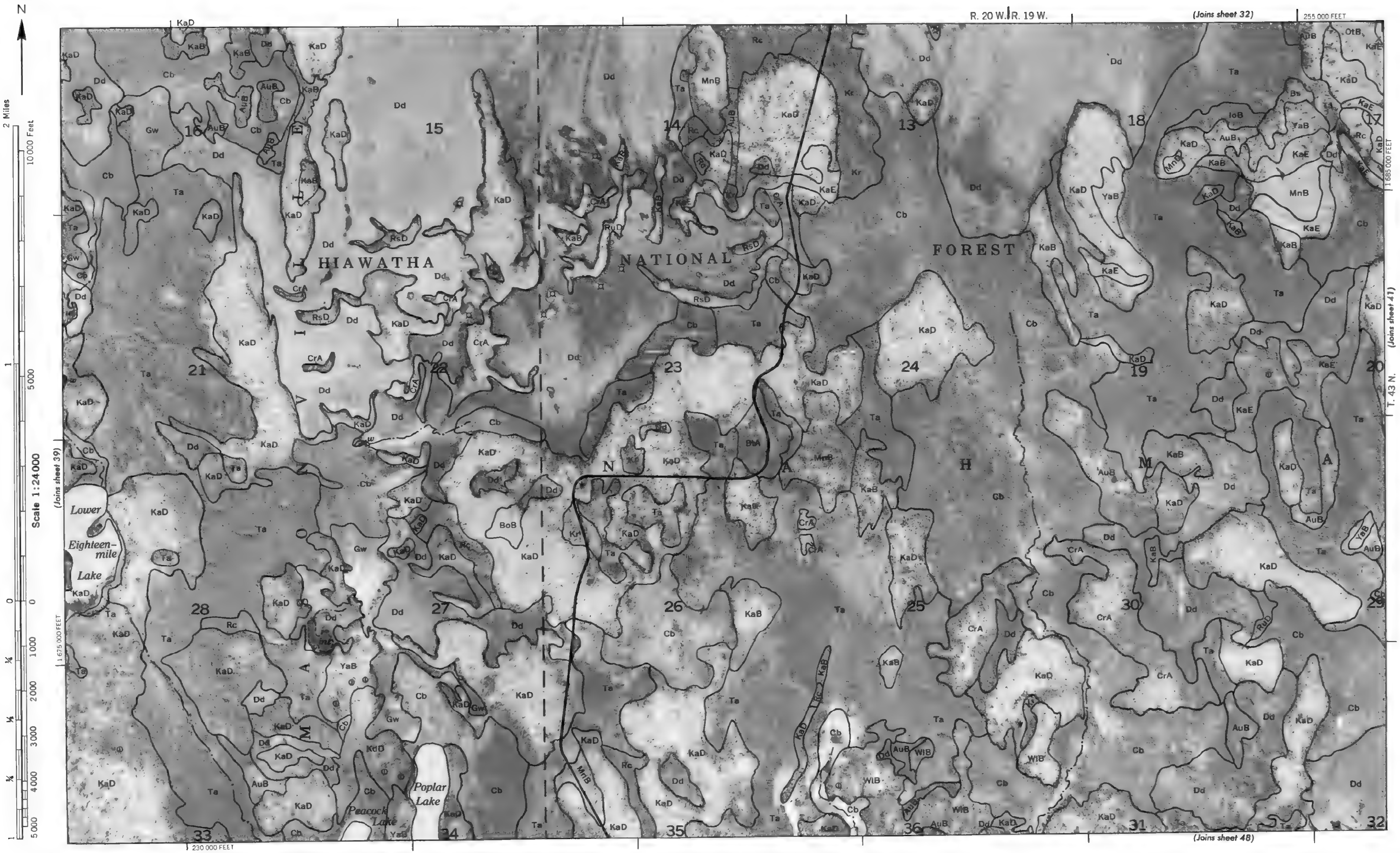


DELTA COUNTY AREA, MICHIGAN NO. 39

This map is compiled on 1954 and 1970 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 40

DELTA COUNTY AREA, MICHIGAN NO. 41

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and division corners, if shown, are approximately positioned

260 000 FEET

1 685 000 FEET

R. 19 W.

R. 18 W.

(Joins sheet 33)

T. 43 N.

HIAWATHA NATIONAL FOREST

Dana Lake

water

Sturgeon River

(Joins sheet 40)

(Joins sheet 42)

(Joins sheet 49)

1 675 000 FEET

285 000 FEET

N

2 Miles

10000 Feet

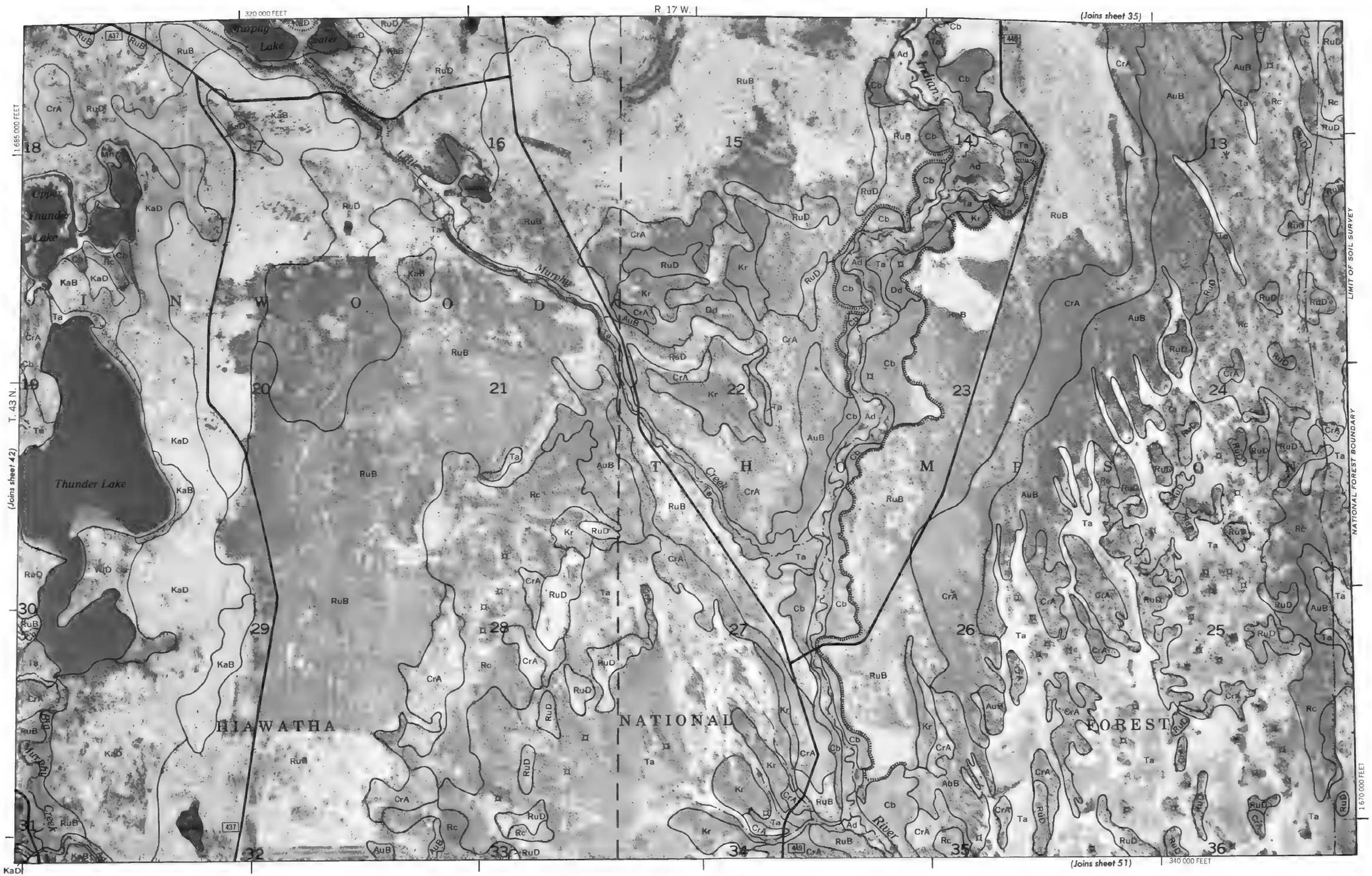
Scale 1:24000

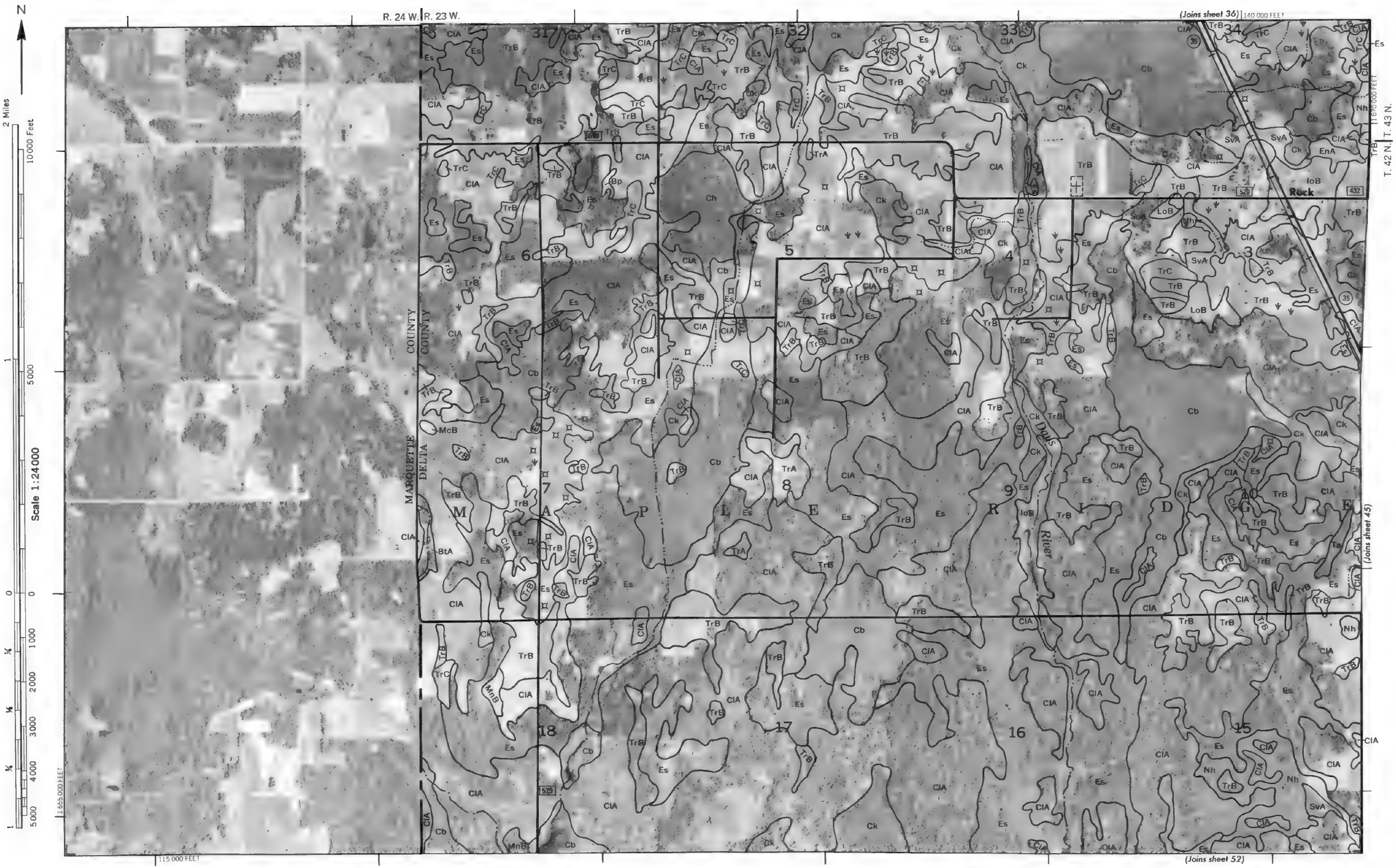
5000 0 1000 2000 3000 4000 5000

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 43

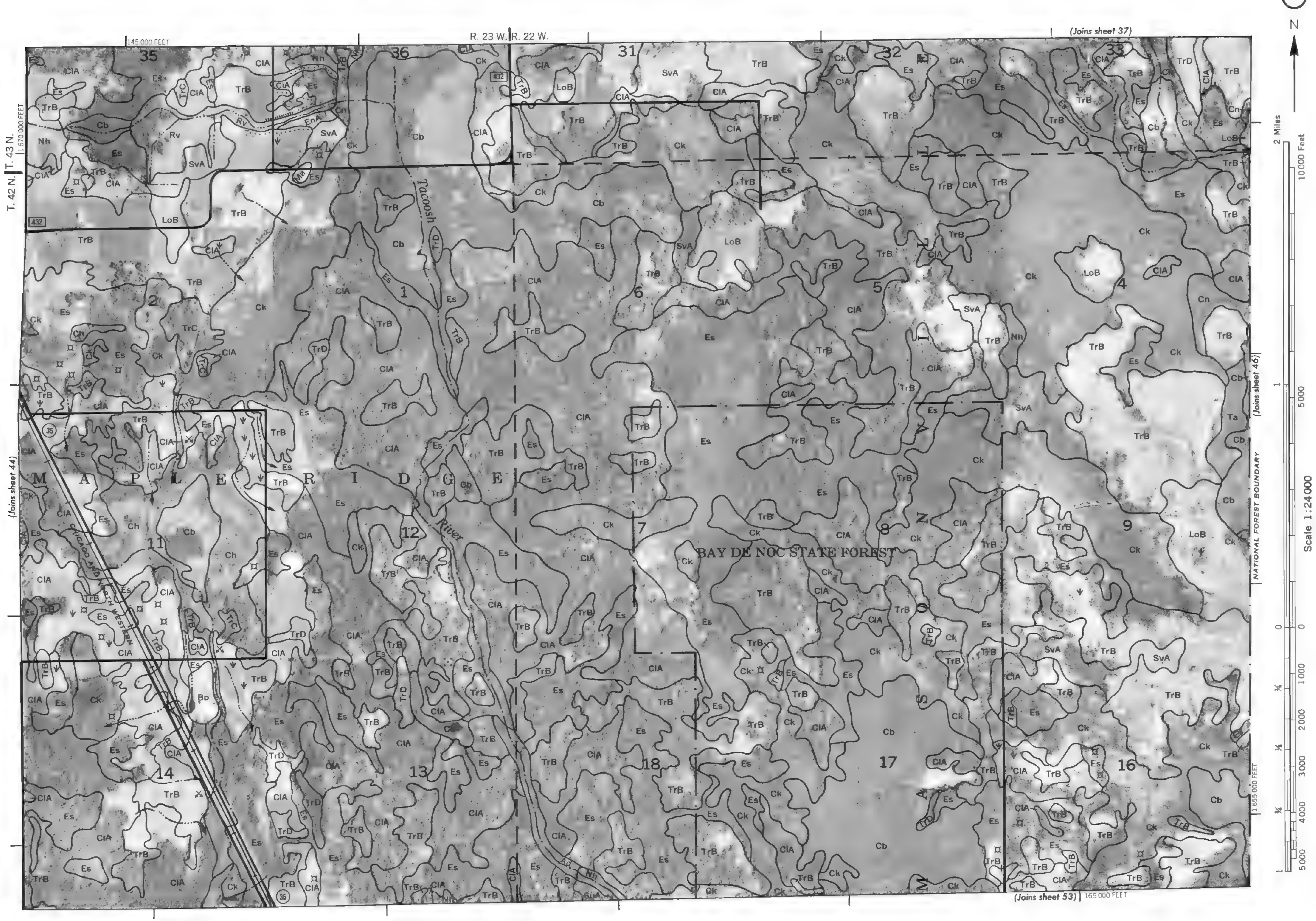
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned





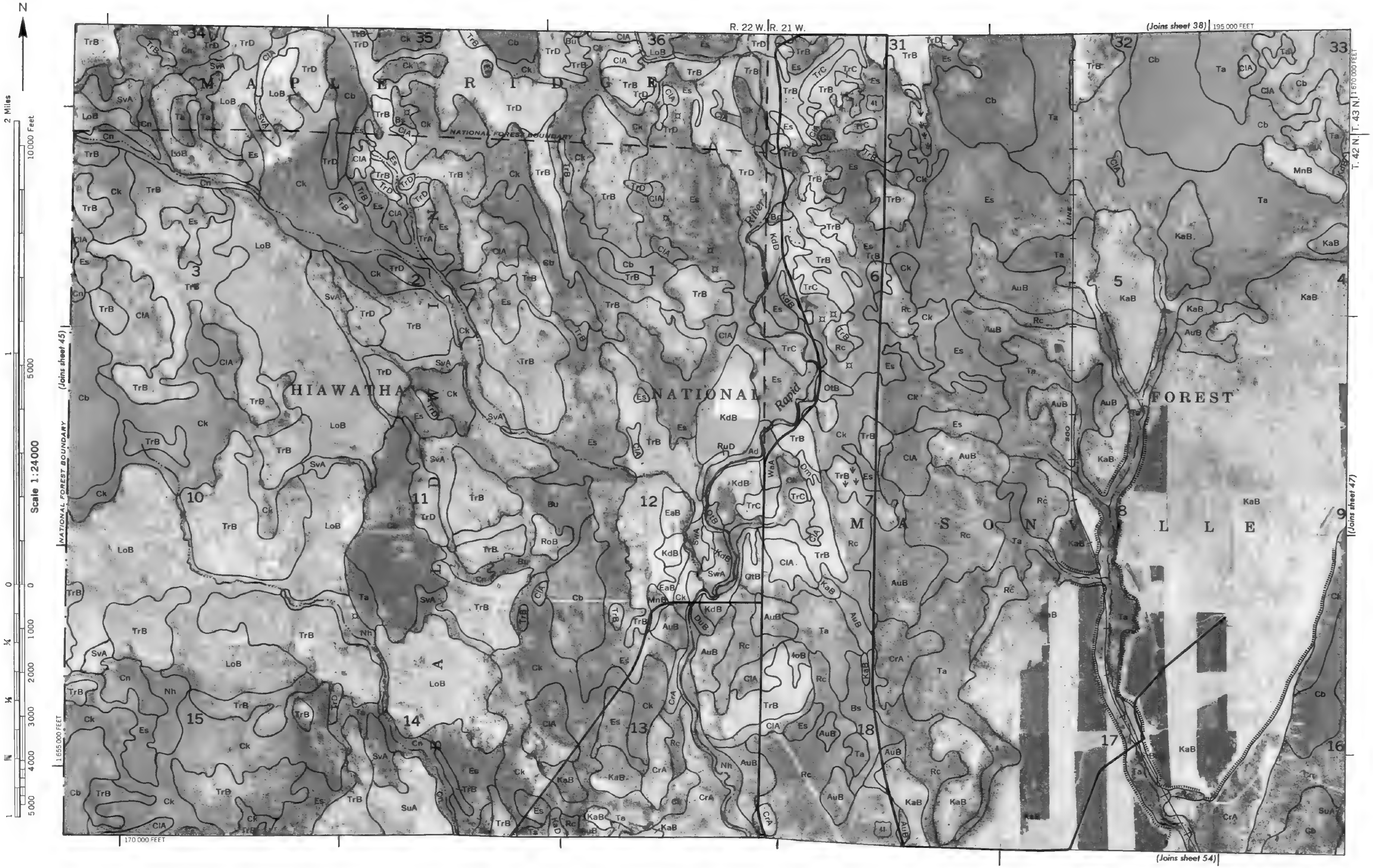
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners if shown are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 44



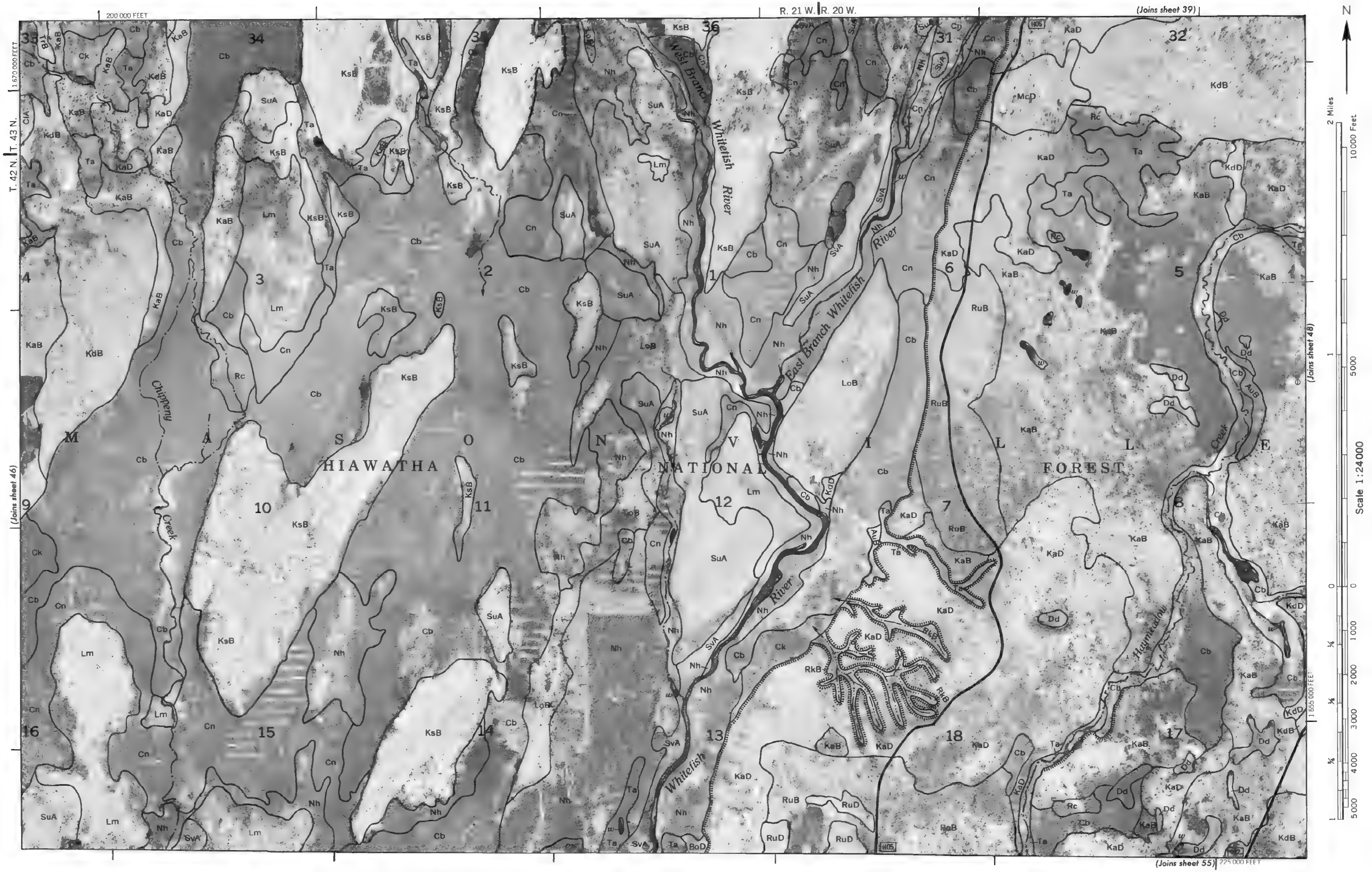
DELTA COUNTY AREA, MICHIGAN NO. 45

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(47)



DELTA COUNTY AREA, MICHIGAN NO. 47

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(48)

N

2 Miles

10000 Feet

1

5000

Scale 1:24000

5000 4000 3000 2000 1000 0 0

R. 20 W. | R. 19 W.

(Joins sheet 40)

255 000 FEET

T. 42 N. | T. 43 N.

1 670 000 FEET

(Joins sheet 47)

1 565 000 FEET

230 000 FEET

(Joins sheet 56)

(Joins sheet 49)

HIAWATHA NATIONAL FOREST

Peacock Lake

Poplar Lake

Haymeadow Creek

Sturgeon River

McDonald Lake

Waco Lake

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land lines on corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 48

DELTA COUNTY AREA, MICHIGAN NO. 49

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

260 000 FEET

285 000 FEET

T. 42 N. | T. 43 N. 1 670 000 FEET

1 655 000 FEET

R. 19 W. | R. 18 W.

(Joins sheet 41)

(Joins sheet 48)

(Joins sheet 50)

(Joins sheet 57)

HIAWATHA NATIONAL FOREST

Sturgeon River

Creek D

Eighteenmile

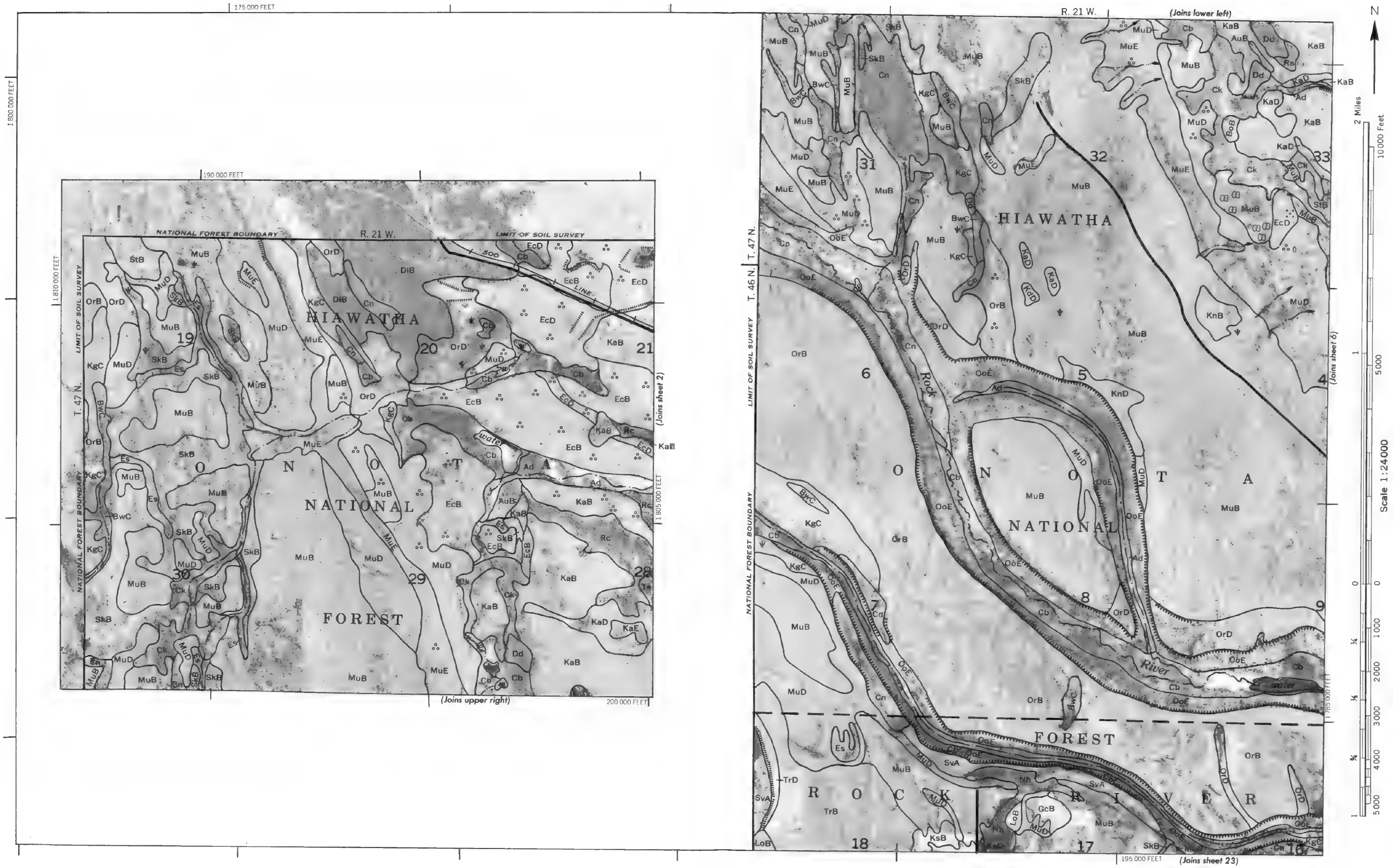
Chicago Lake

N

2 Miles 1 0 1

10000 Feet 5000 0 1000 2000 3000 4000 5000

Scale 1:24000



DELTA COUNTY AREA, MICHIGAN NO. 5
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

50

N

2 Miles

10000 Feet

1 5000

Scale 1:24000

0 0

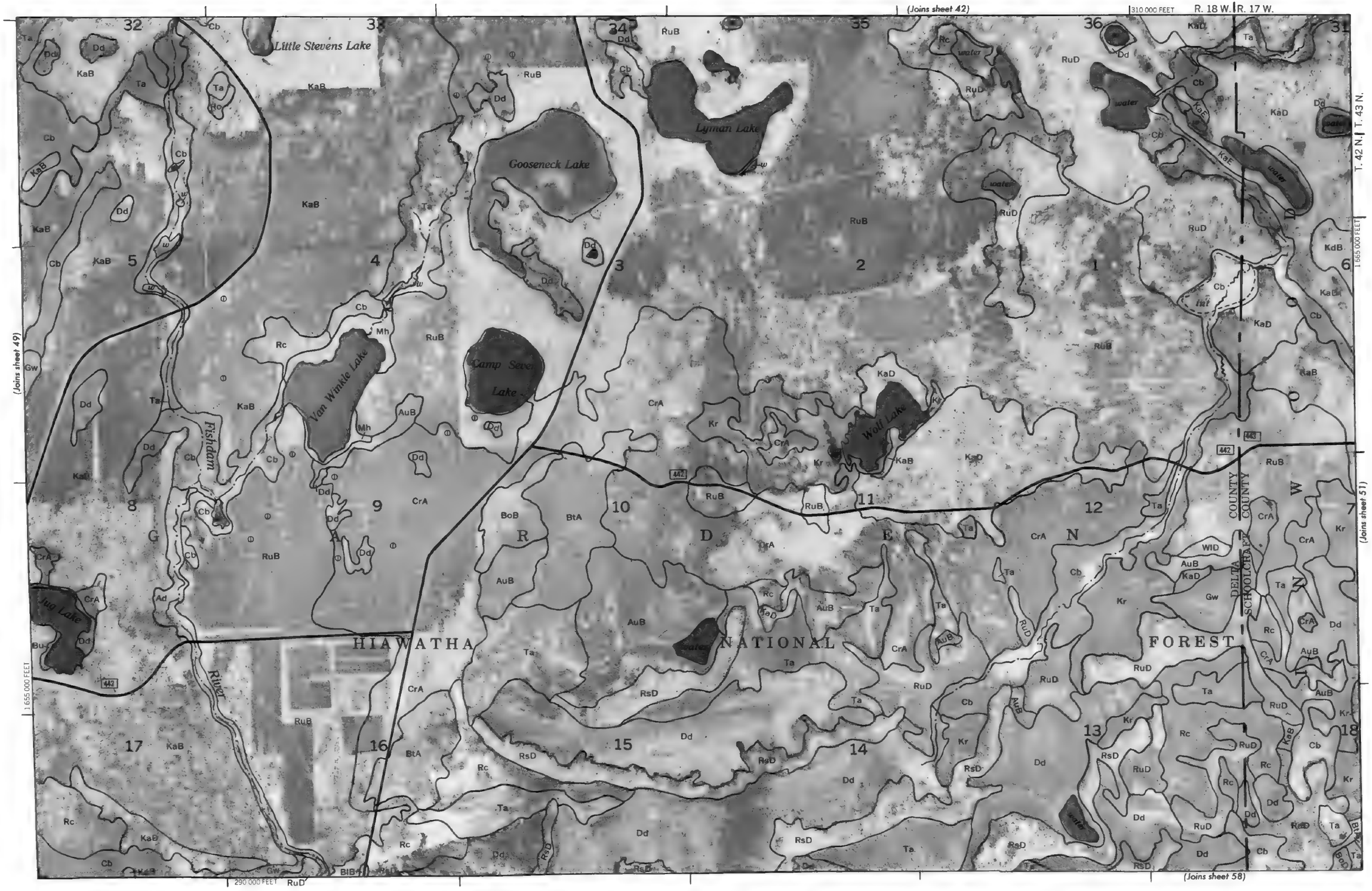
¼ 1000

½ 2000

¾ 3000

1 4000

5000

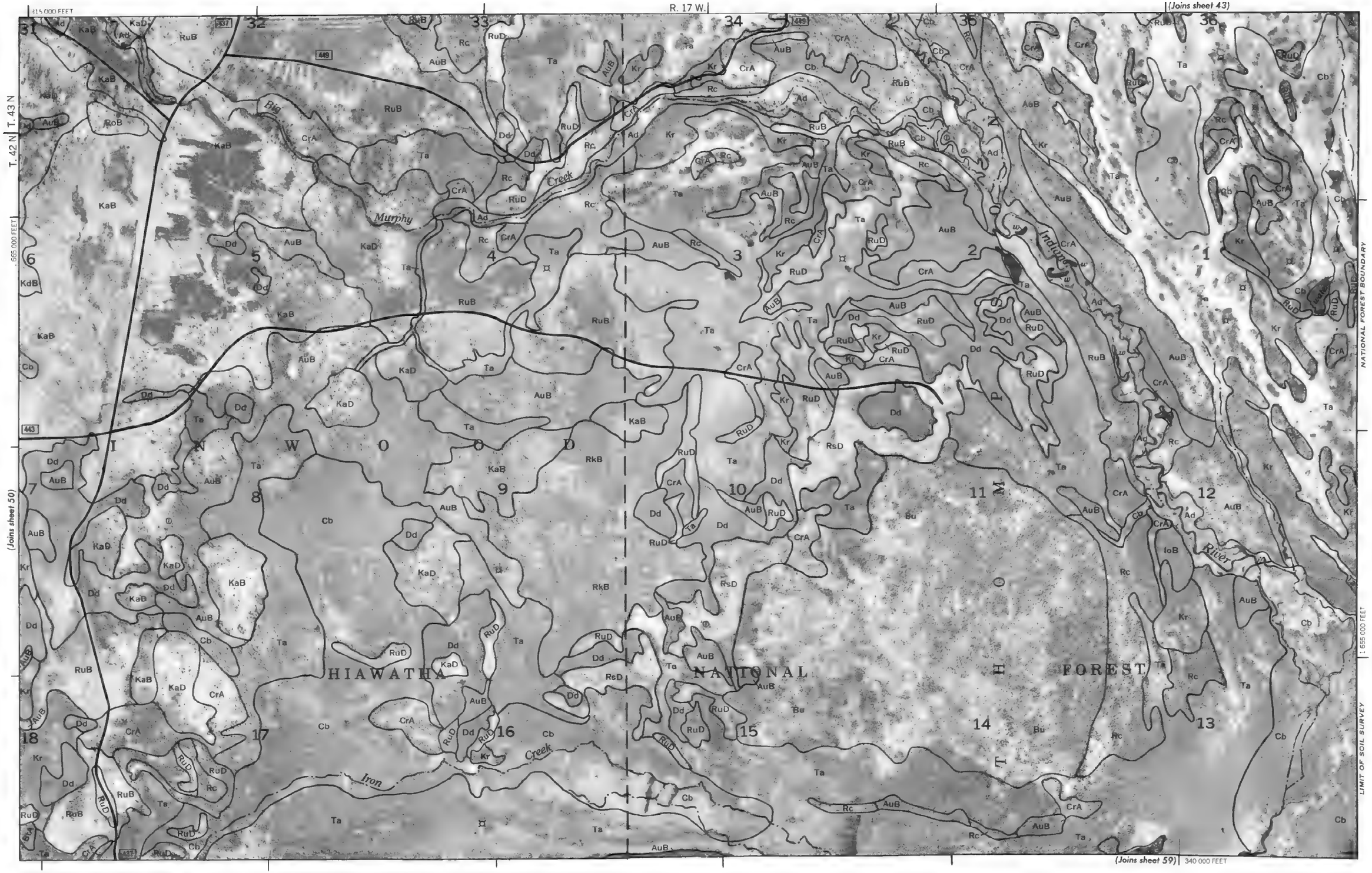


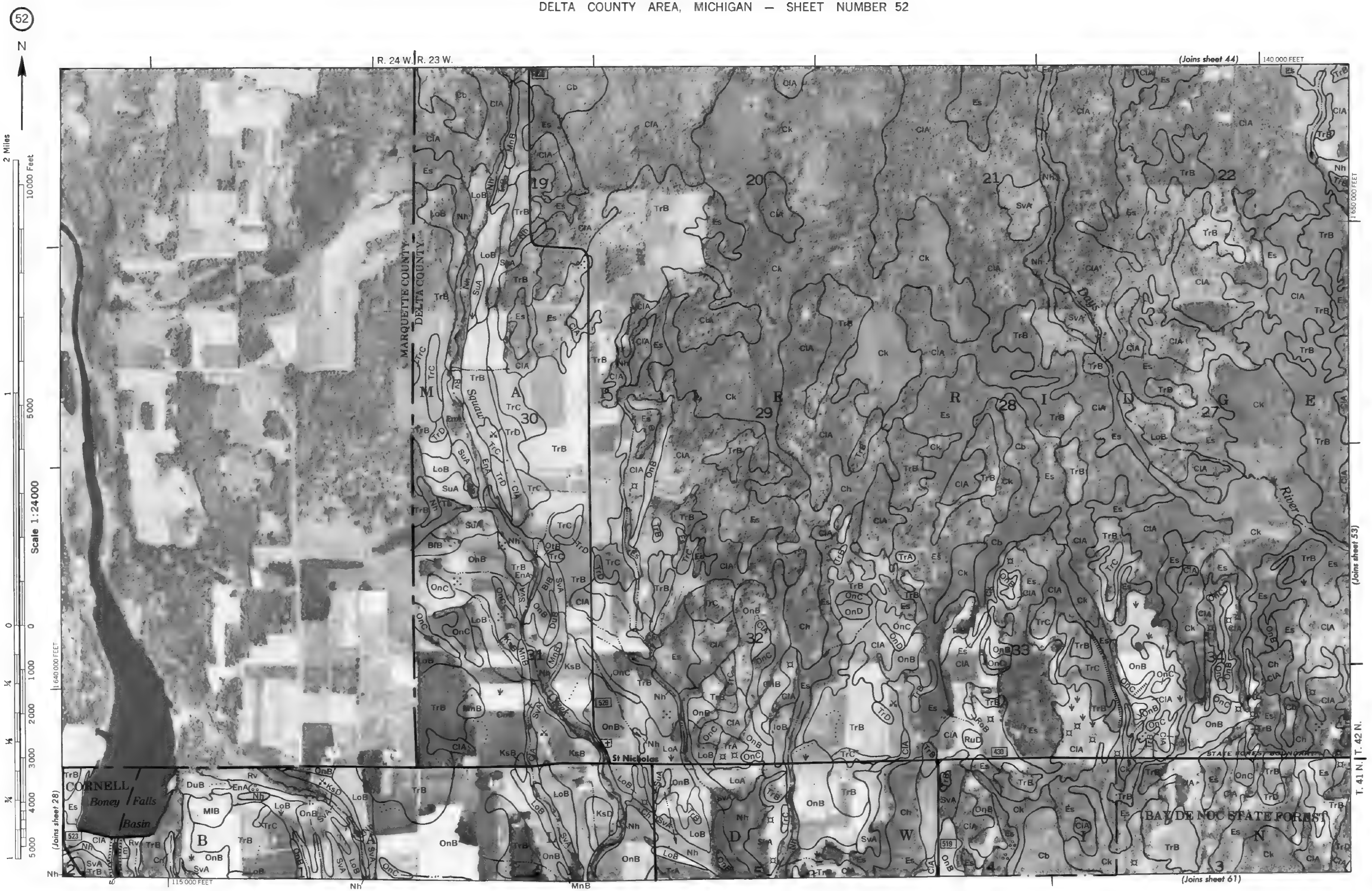
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 50

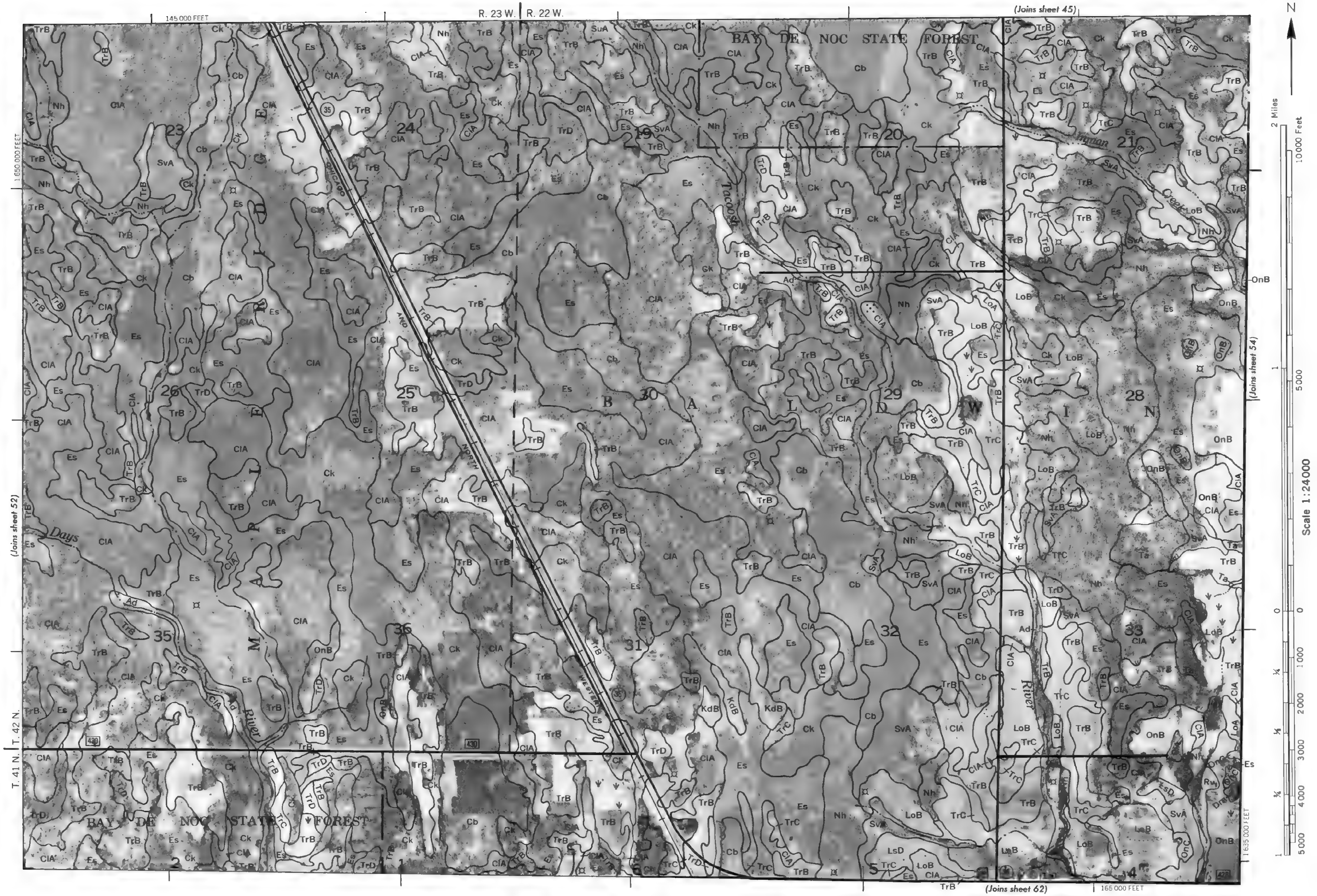
DELTA COUNTY AREA, MICHIGAN NO. 51

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned





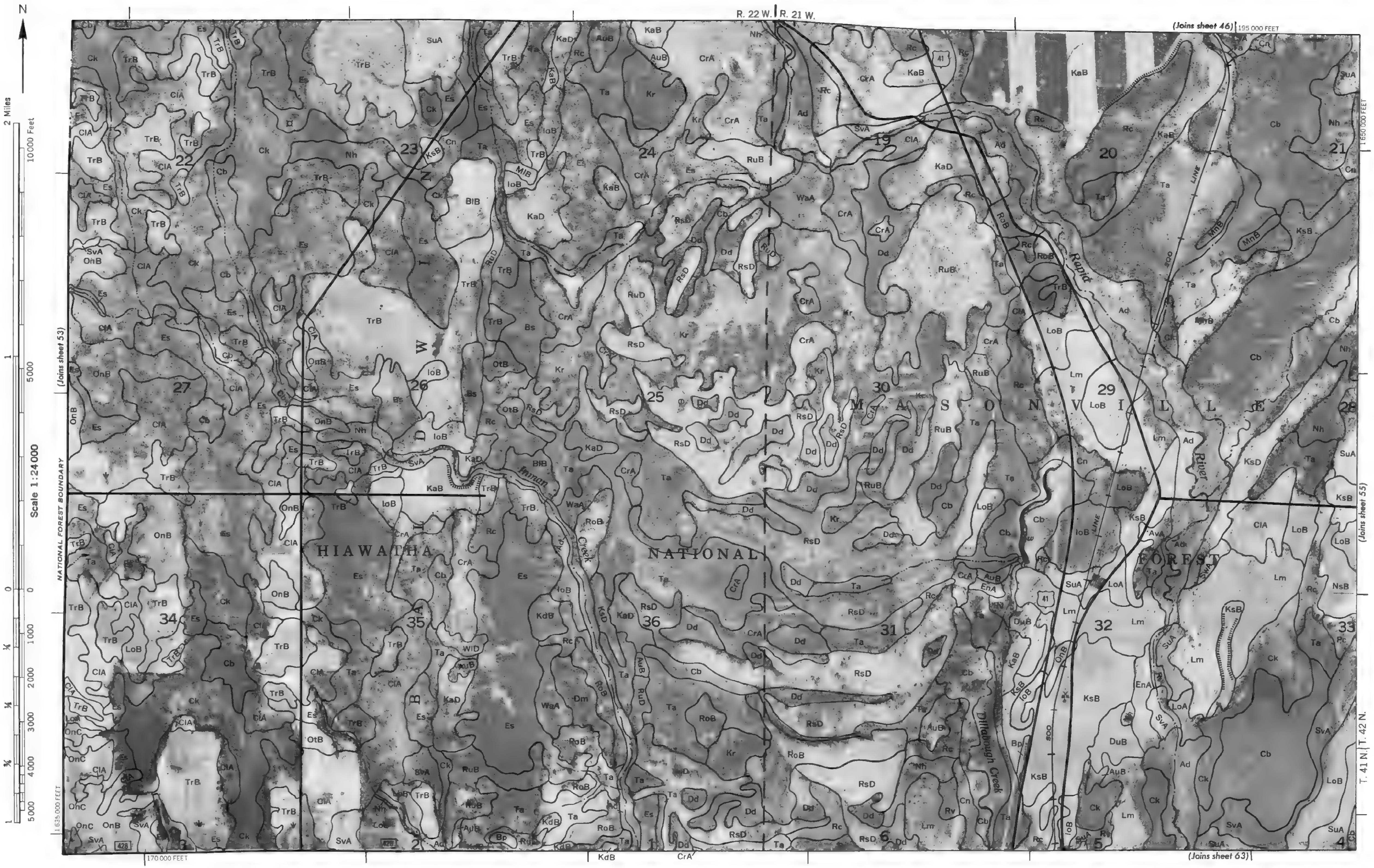
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



DELTA COUNTY AREA, MICHIGAN NO. 53

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN — SHEET NUMBER 54



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 55

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

56

N

2 Miles 10000 Feet

1 5000 0

Scale 1:24000

¾ 4000 ¼ 3000 ½ 2000 ¾ 1000 0

1 5000

R. 20 W. | R. 19 W.

(Joins sheet 48)

255 000 FEET

1 650 000 FEET

(Joins sheet 55)

1 635 000 FEET

230 000 FEET

(Joins sheet 57)

(Joins sheet 65)

T. 41 N. | T. 42 N.

Bishop Lake

Sturgeon River

Lost Lakes

water

HIAWATHA NATIONAL FOREST

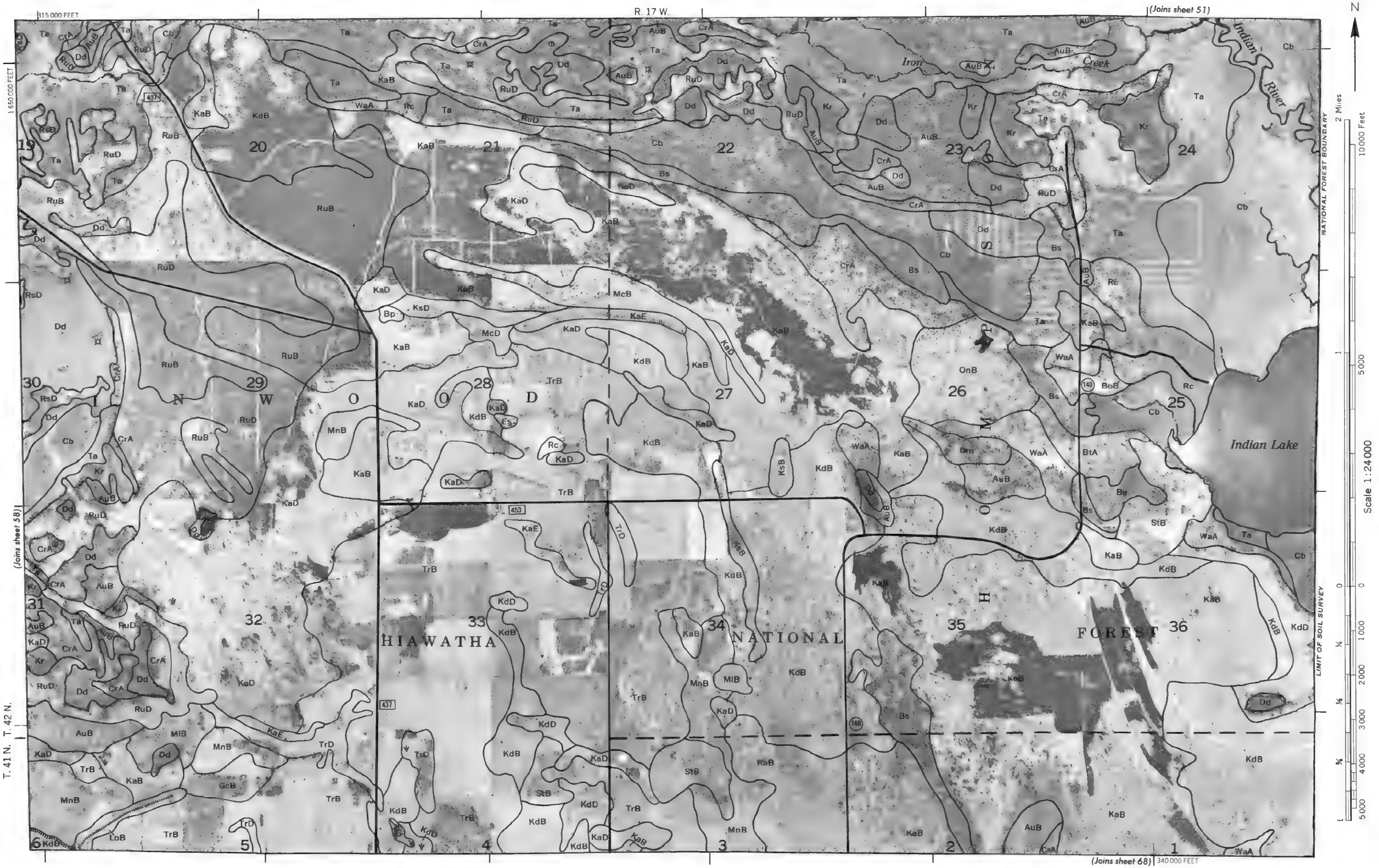
This map was compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 56

DELTA COUNTY AREA, MICHIGAN NO. 57

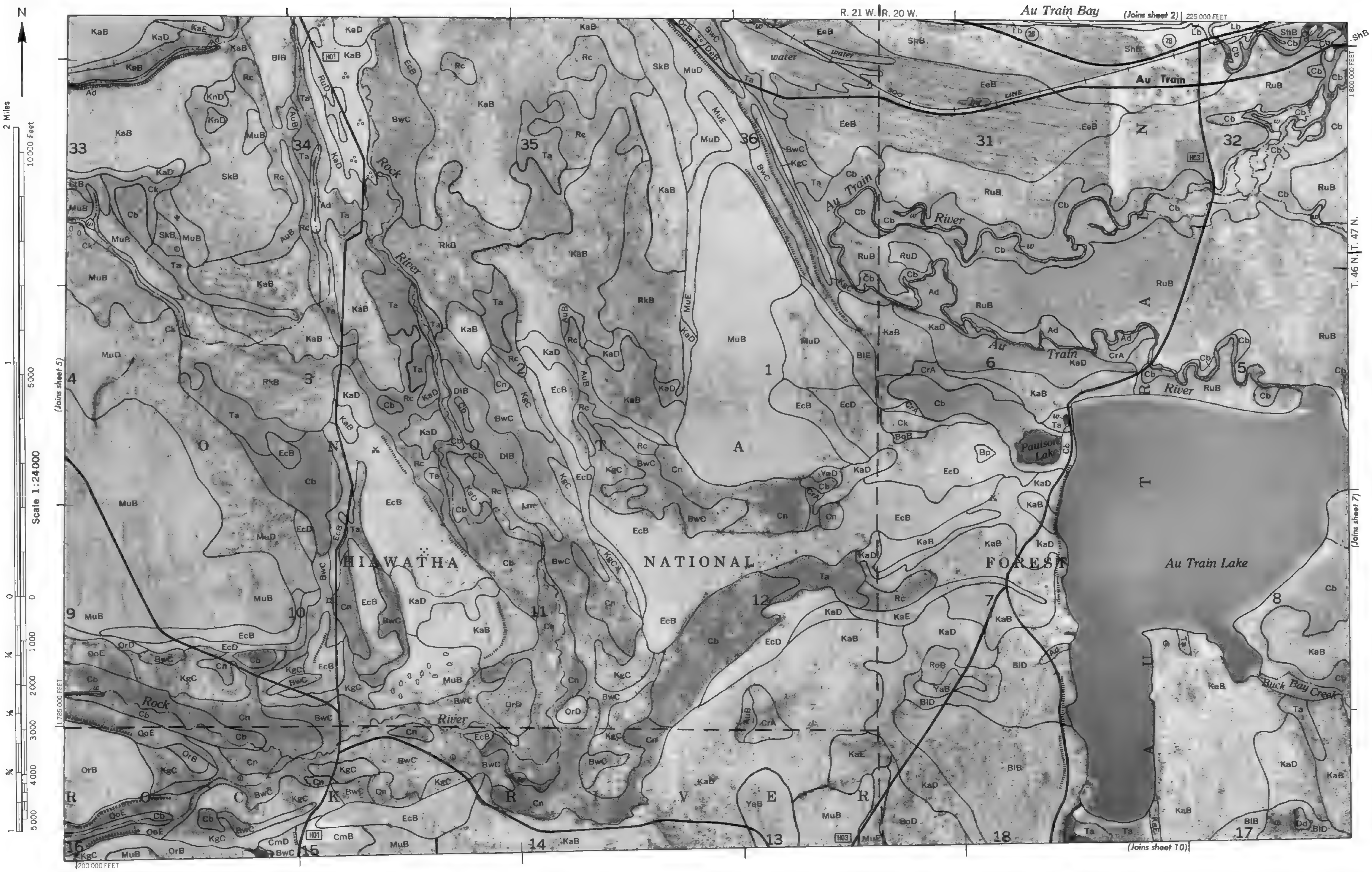
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

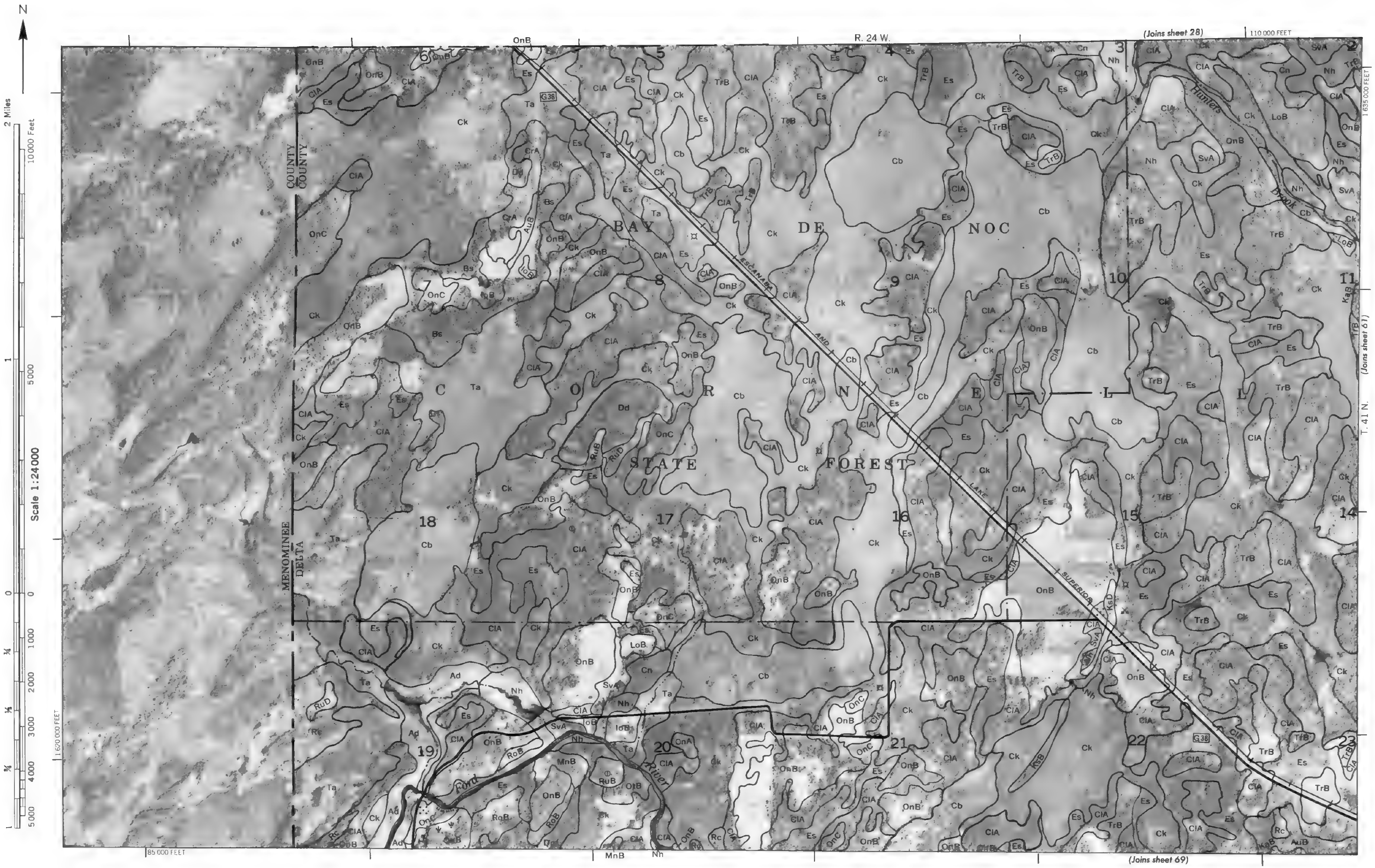


DELTA COUNTY AREA, MICHIGAN NO. 59

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1964 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 61

This map is compiled on 1954 exc. 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

MARQUETTE COUNTY

R. 24 W. R. 23 W.

T. 41 N.

(Joins sheet 60)

(Joins sheet 52)

(Joins sheet 62)

(Joins sheet 70)

1 635 000 FEET

1 620 000 FEET

115 000 FEET

140 000 FEET

Escanaba

Es Hunters

Ford

River

CORNELL

BAY DE NOC STATE FOREST

BAY DE NOC STATE FOREST

N

2 Miles

10000 Feet

5000

Scale 1:24000

62

N

R. 23 W. | R. 22 W.

(Joins sheet 53)

165 000 FEET

BAY DE NOC

STATE FOREST

Days River

CHICAGO AND NORTH WESTERN

Perkins

Brampton

T. 41 N.

(Joins sheet 61)

(Joins sheet 63)

(Joins sheet 71)

145 000 FEET

1 620 000 FEET

1 630 000 FEET

2 Miles

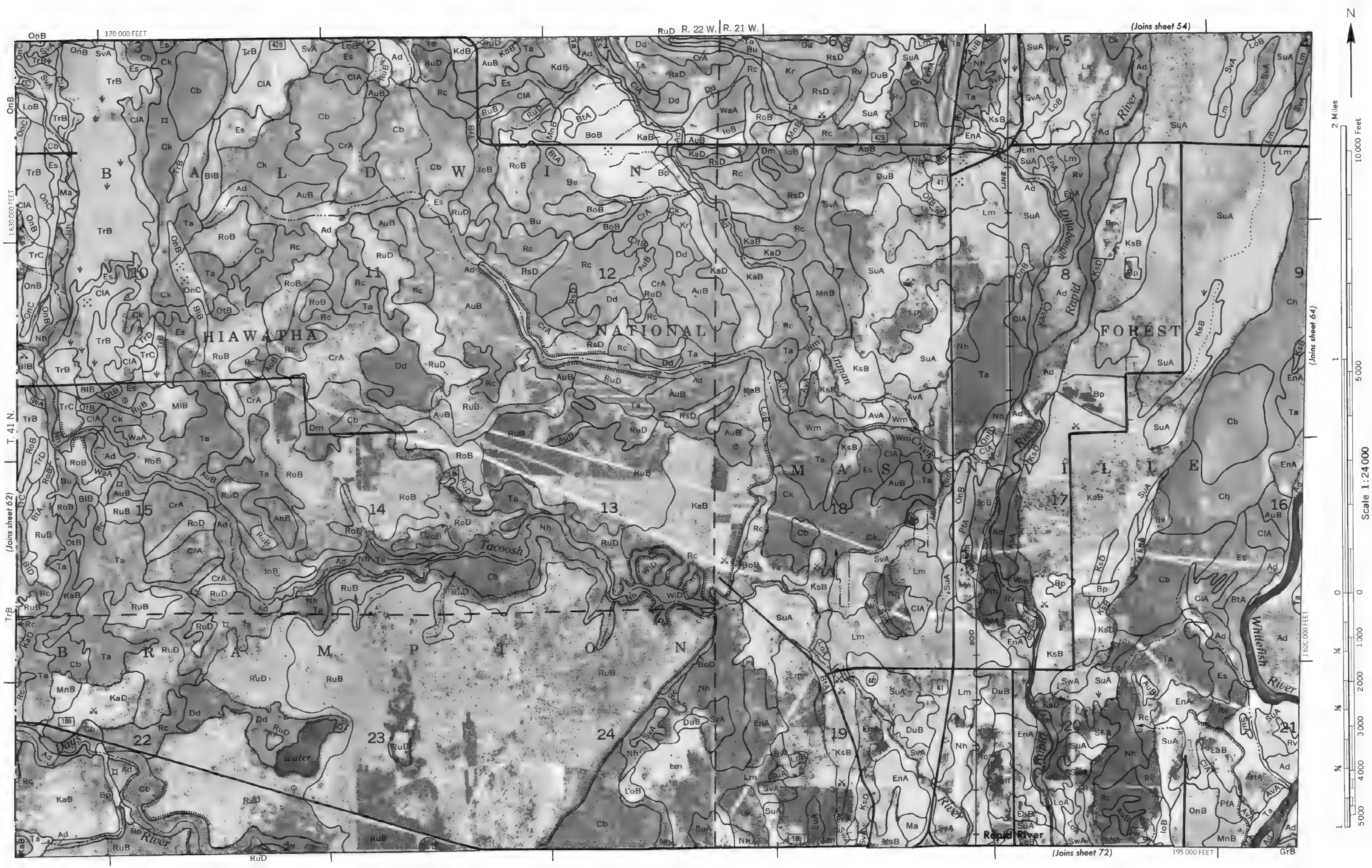
10 000 Feet

Scale 1:24 000

1 5000 0 1000 2000 3000 4000 5000

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 62



DELTA COUNTY AREA, MICHIGAN NO. 63

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN — SHEET NUMBER 64

64

N

R. 21 W. | R. 20 W.

(Joins sheet 55)

225 000 FEET

1 630 000 FEET

T. 41 N.

(Joins sheet 65)

(Joins sheet 63)

1 620 000 FEET

200 000 FEET

(Joins sheet 73)

HIAWATHA NATIONAL FOREST

ALGER

DELTA COUNTY AREA, MICHIGAN NO. 64

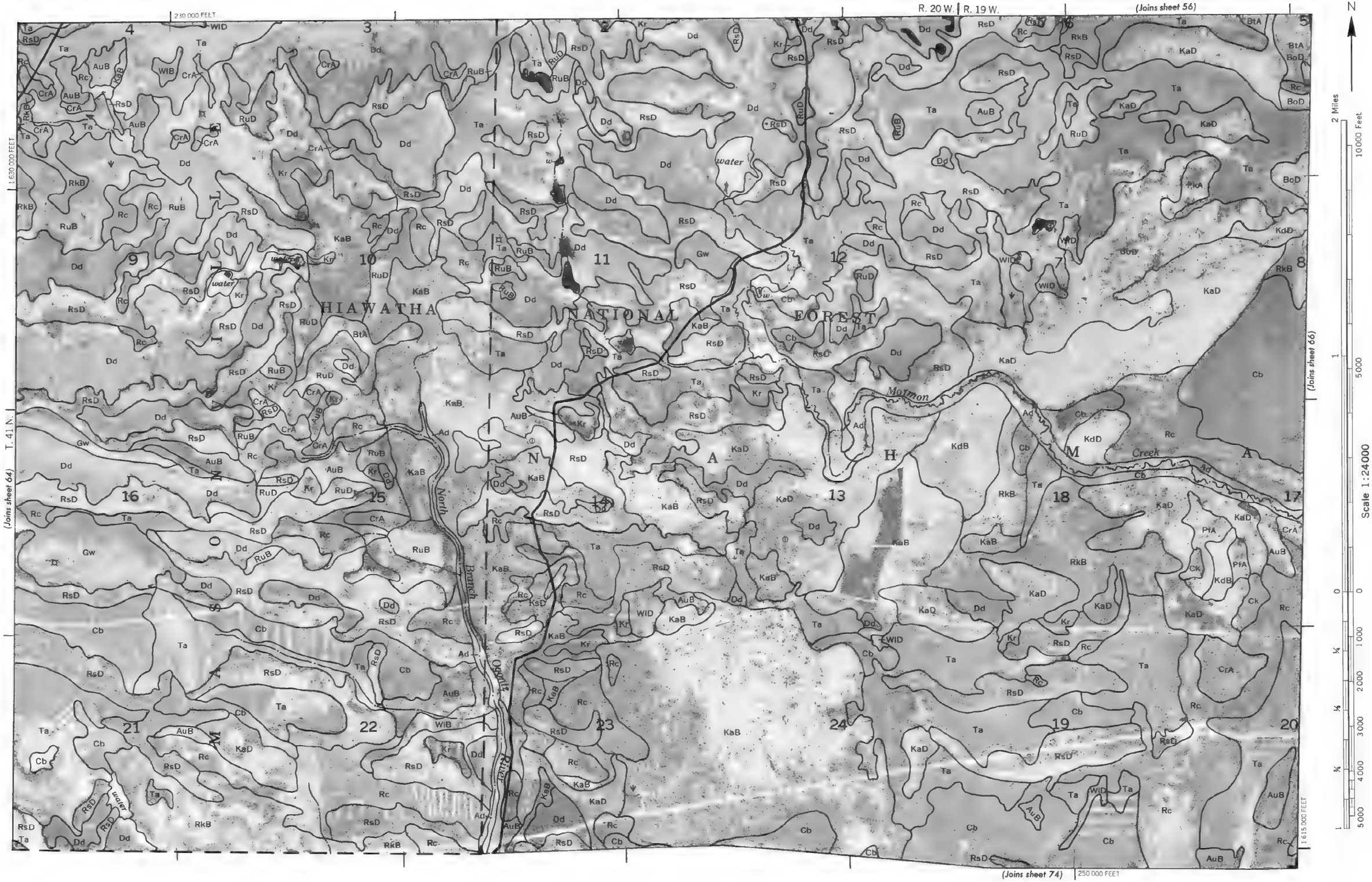
Scale 1:24000

2 Miles 10000 Feet 5000 0 1000 2000 3000 4000 5000

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 65

This map is compiled on 1954 and 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned



N

R. 19 W. R. 18 W.

(Joins sheet 57)

285 000 FEET

1 630 000 FEET

T. 41 N.

(Joins sheet 67)

(Joins sheet 65)

(Joins sheet 75)

1 615 000 FEET

255 000 FEET

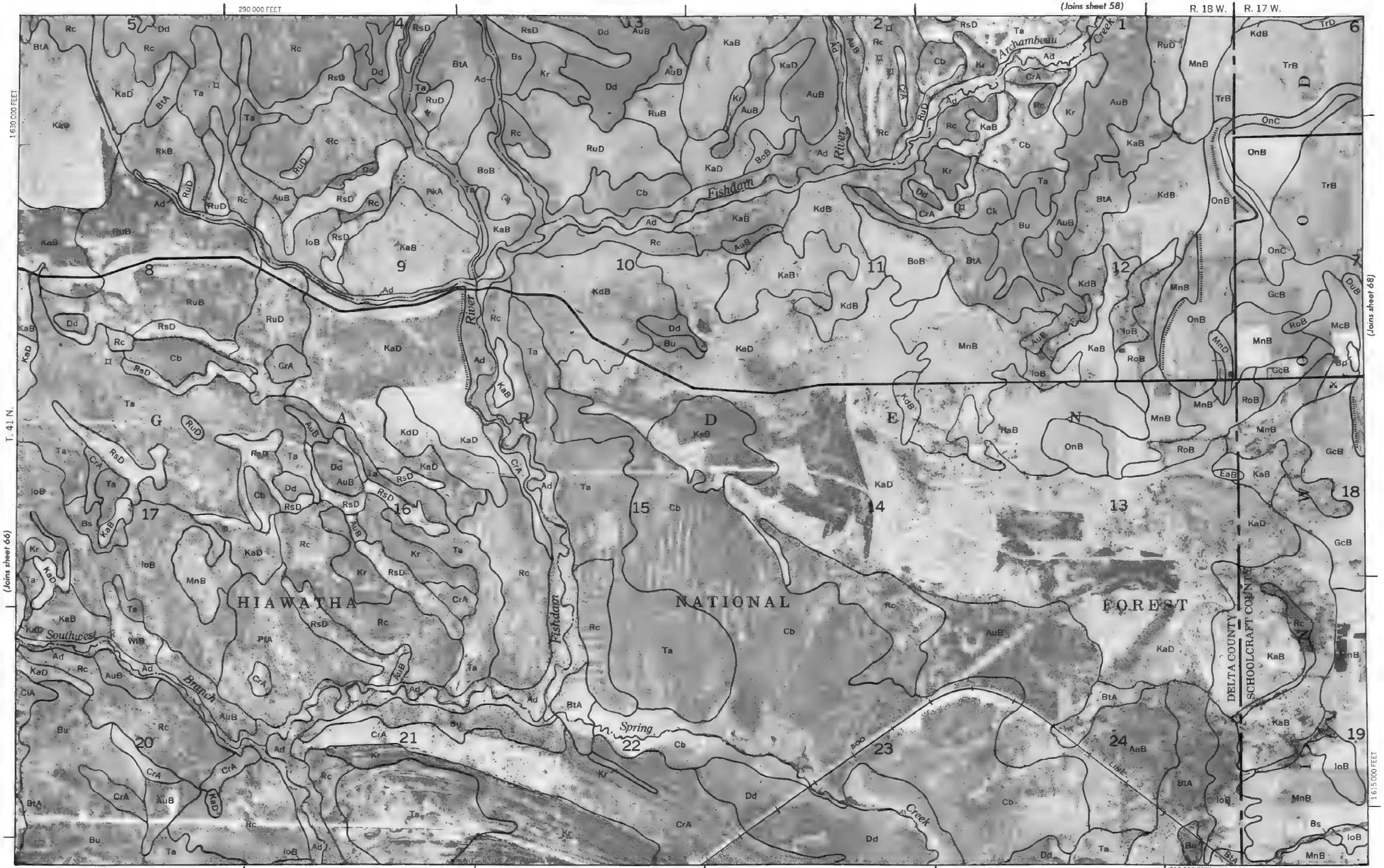
HIAWATHA NATIONAL FOREST

Scale 1:24000

2 Miles 10000 Feet 5000

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 67
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned



68

N

R. 17 W.

(Joins sheet 59)

340 000 FEET

T. 41 N.

(Joins sheet 67)

1 630 000 FEET

1 635 000 FEET

315 000 FEET

(Joins sheet 77)

2 Miles 10000 Feet

Scale 1:24000

HIAWATHA NATIONAL FOREST

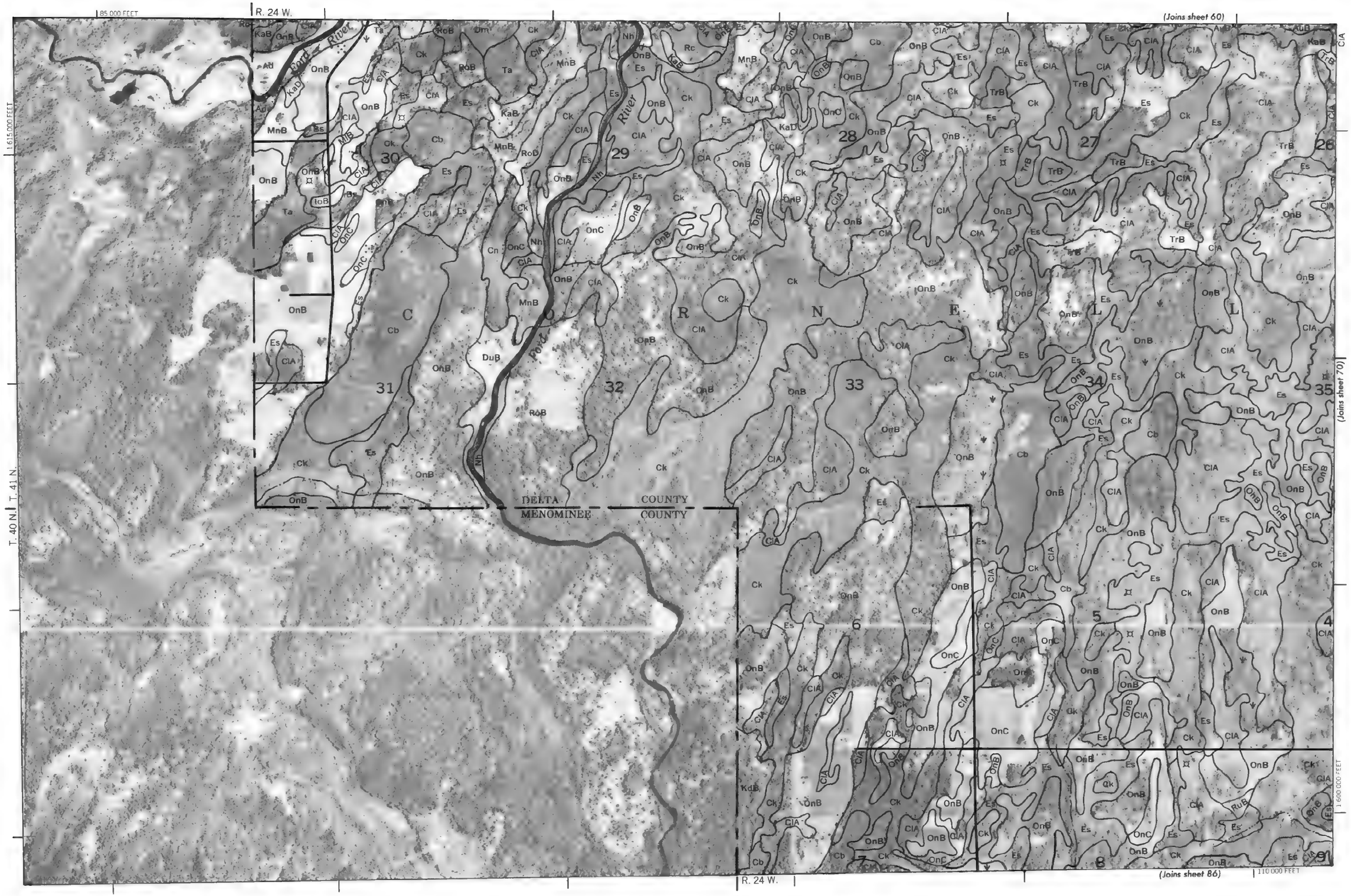
LIMIT OF SOIL SURVEY

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 68

DELTA COUNTY AREA, MICHIGAN NO. 69

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned



DELTA COUNTY AREA, MICHIGAN NO. 7

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

This map is compiled on 1954 and 1970 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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DELTA COUNTY AREA, MICHIGAN NO. 70

71

N

2 Miles

10 000 Feet

1

5000

Scale 1:24 000

DELTA COUNTY AREA, MICHIGAN NO. 71

This map is compiled on 1954 and 1970 aer al photography by the U S Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land omission corners, if shown, are approximately positioned

72

N
2 Miles
10000 Feet
Scale 1:24 000
(Joins sheet 71)
(Joins sheet 63)
(Joins sheet 73)
(Joins sheet 80)
R. 22 W. | R. 21 W.
T. 40 N. | T. 41 N.
195 000 FEET
1 615 000 FEET
1 600 000 FEET
170 000 FEET
HIAWATHA NATIONAL FOREST
HAMPTON
MASONVILLE
ENSIGN
LITTLE BAY DE NOC
Masonville
Rapid River
Garth Point
Whitefish Point
Days River
Whitefish
Schaawe Lake
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.
DELTA COUNTY AREA, MICHIGAN NO. 72

DELTA COUNTY AREA, MICHIGAN NO. 73

This map is compiled on 1954 and 1970 aerial photography by the U S Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

N

2 Miles 10000 Feet 1 5000

Scale 1:24000

0 0 ¼ 1000 ½ 2000 ¾ 3000 1 4000 5000

R. 20 W. | R. 19 W.

250 000 FEET

(Joins sheet 65)

T. 41 N.

T. 40 N.

(Joins sheet 73)

(Joins sheet 75)

(Joins sheet 82)

1 610 000 FEET

1 600 000 FEET

230 000 FEET

HIAWATHA NATIONAL FOREST

Ogontz River

Johnson Creek

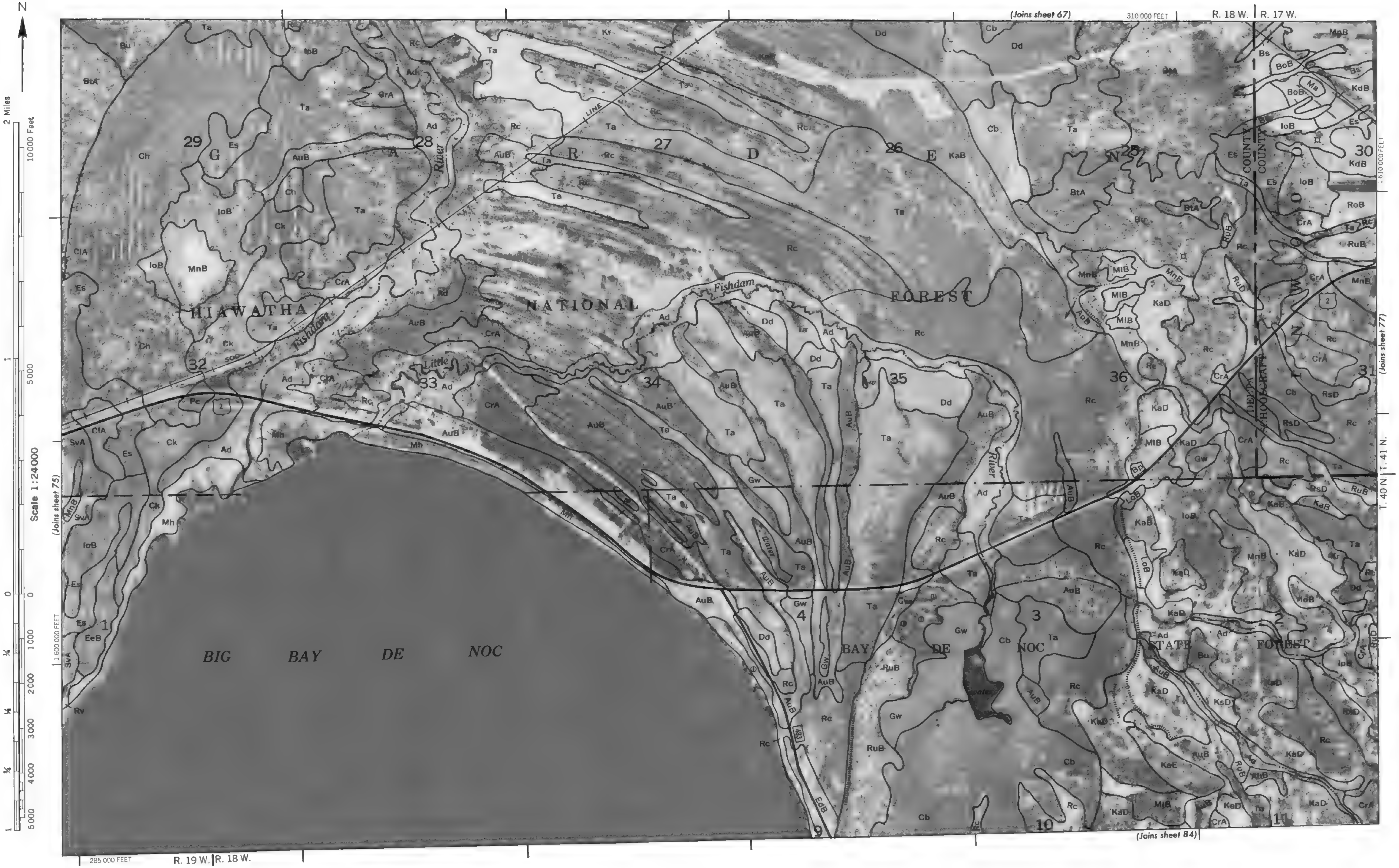
LINE

St Jacques

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Could make grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 74

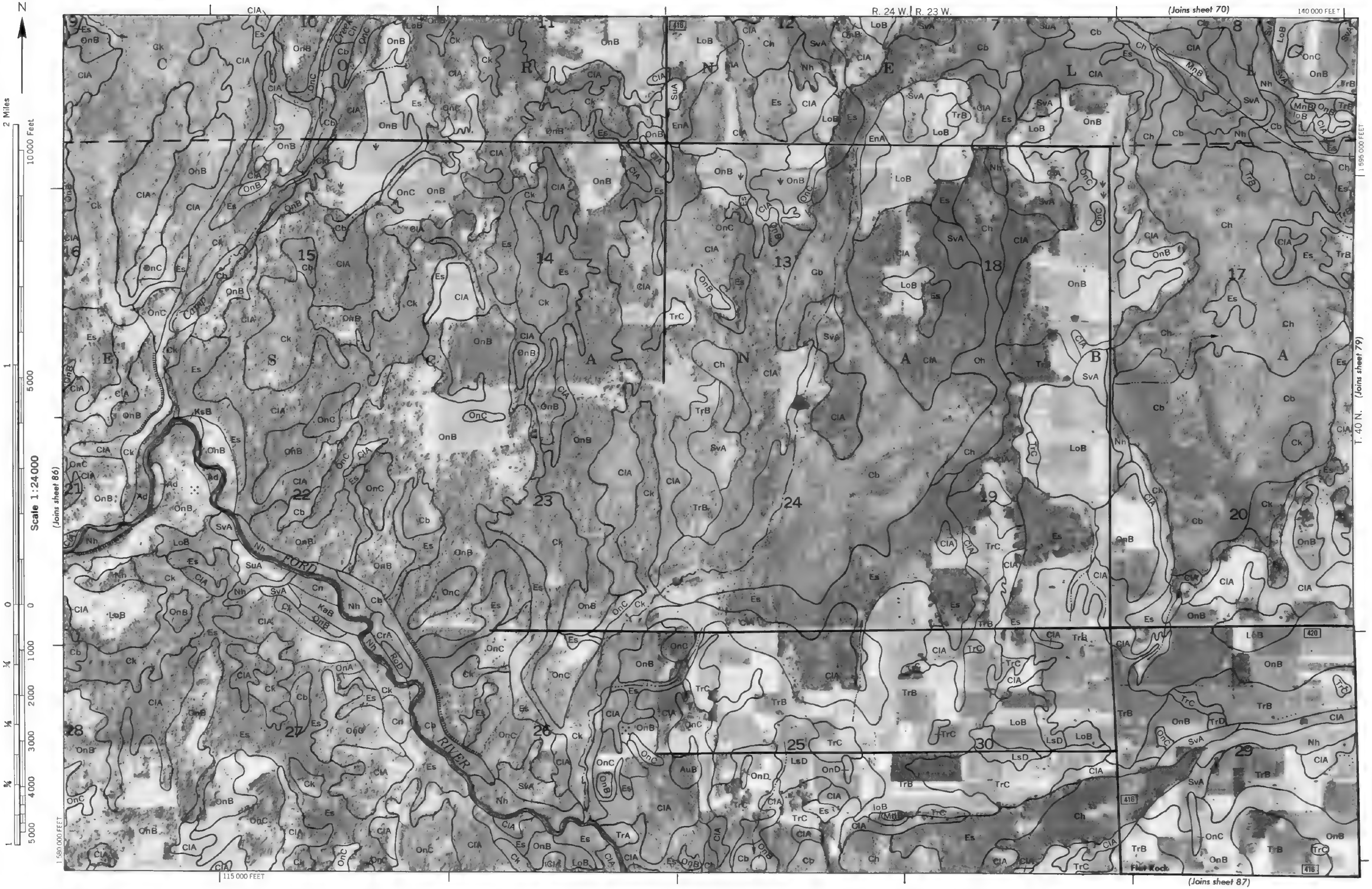
DELTA COUNTY AREA, MICHIGAN NO. 75
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land divisions, if shown, are approximately positioned



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 77

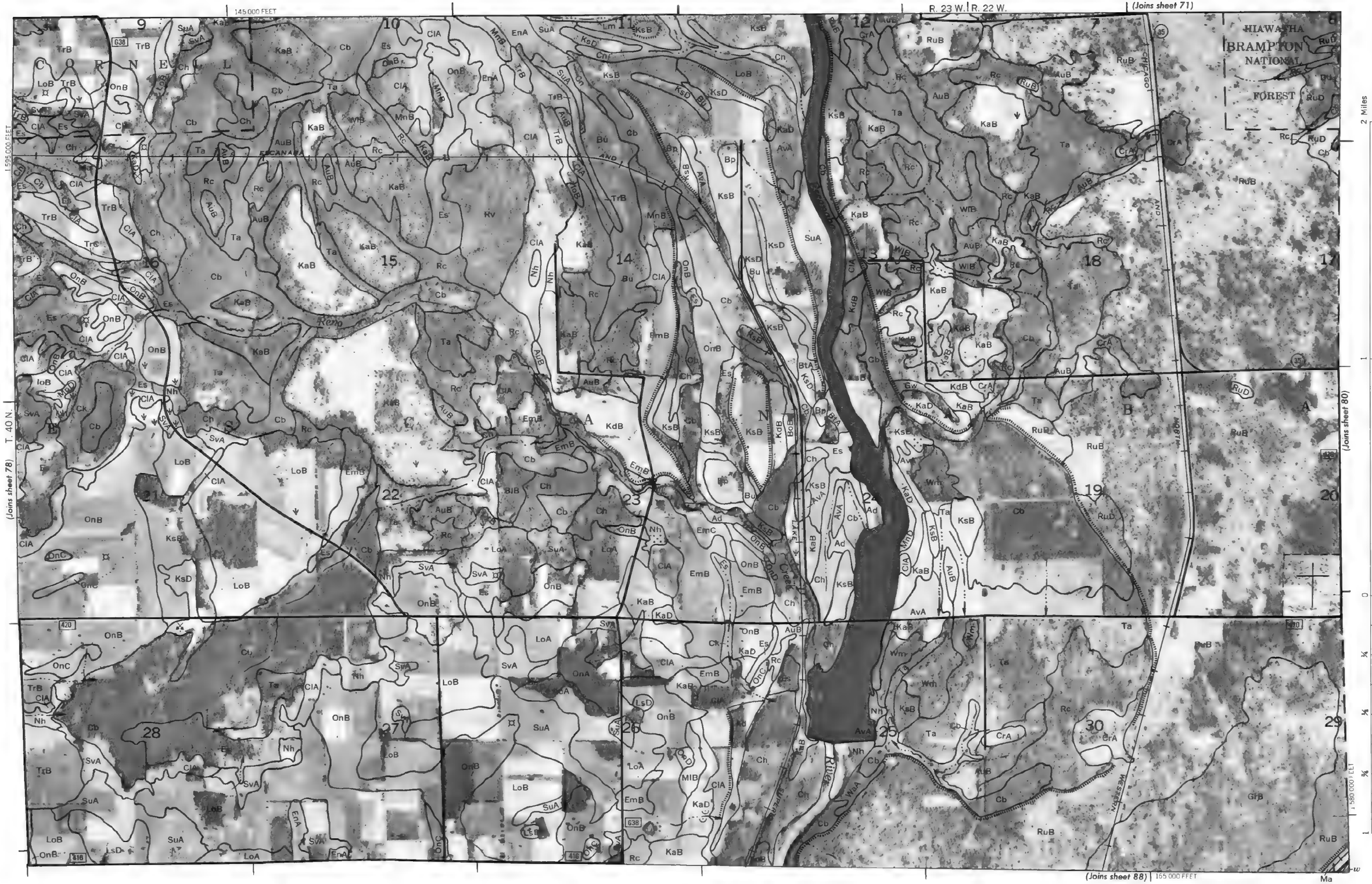
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 78

DELTA COUNTY AREA, MICHIGAN NO. 79



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 8

DELTA COUNTY AREA, MICHIGAN NO. 80

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land divisions, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 81

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

R. 20 W.

(Joins sheet 74)

255 000 FEET

1 595 000 FEET

T. 40 N.

(Joins sheet 81)

(Joins sheet 83)

(Joins sheet 91)

230 000 FEET

1 580 000 FEET

2 Miles

10000 Feet

Scale 1:24000

HIAWATHA NATIONAL FOREST

Ogontz Bay

Ogontz River

Little Big River

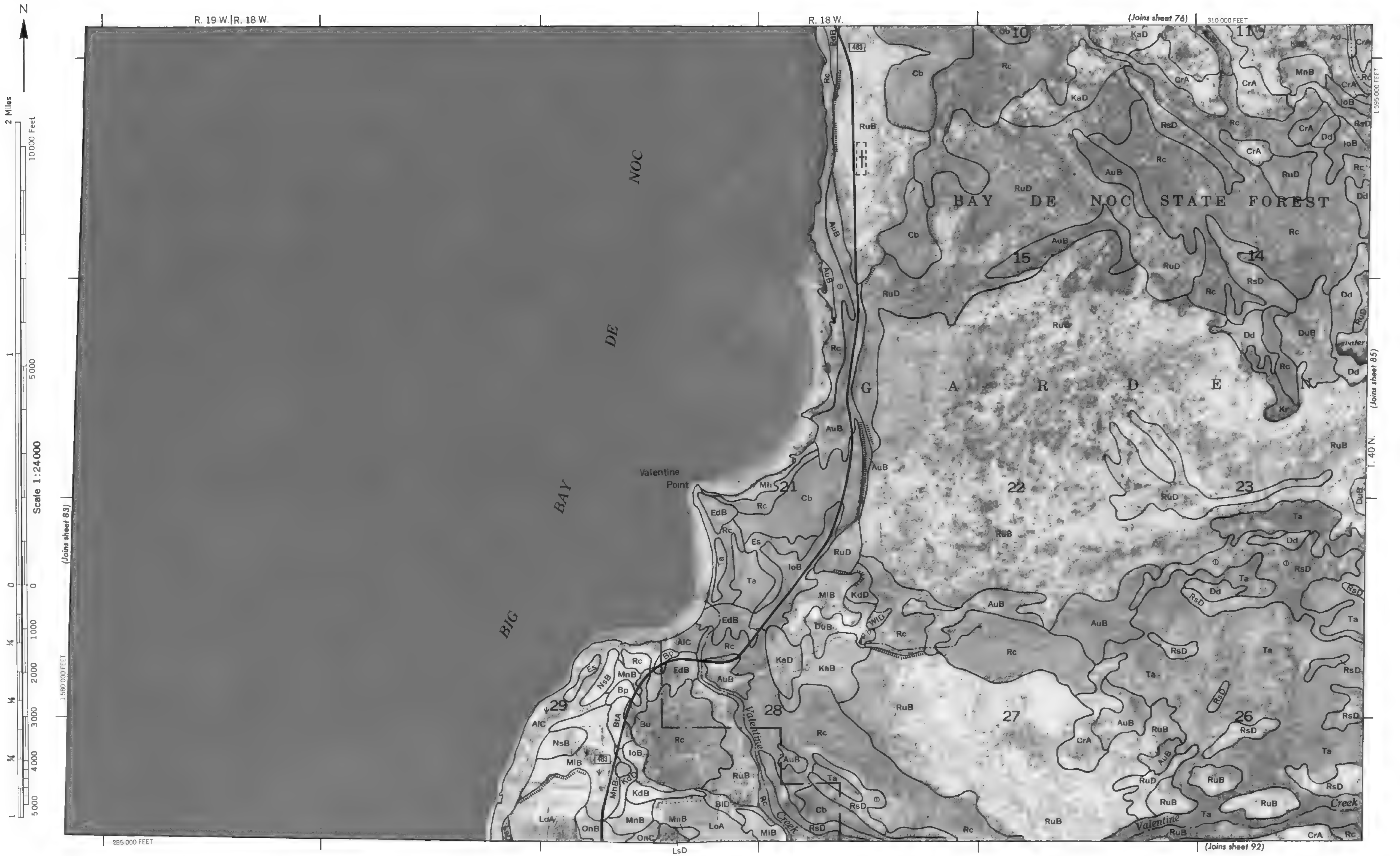
Indian Point

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 82

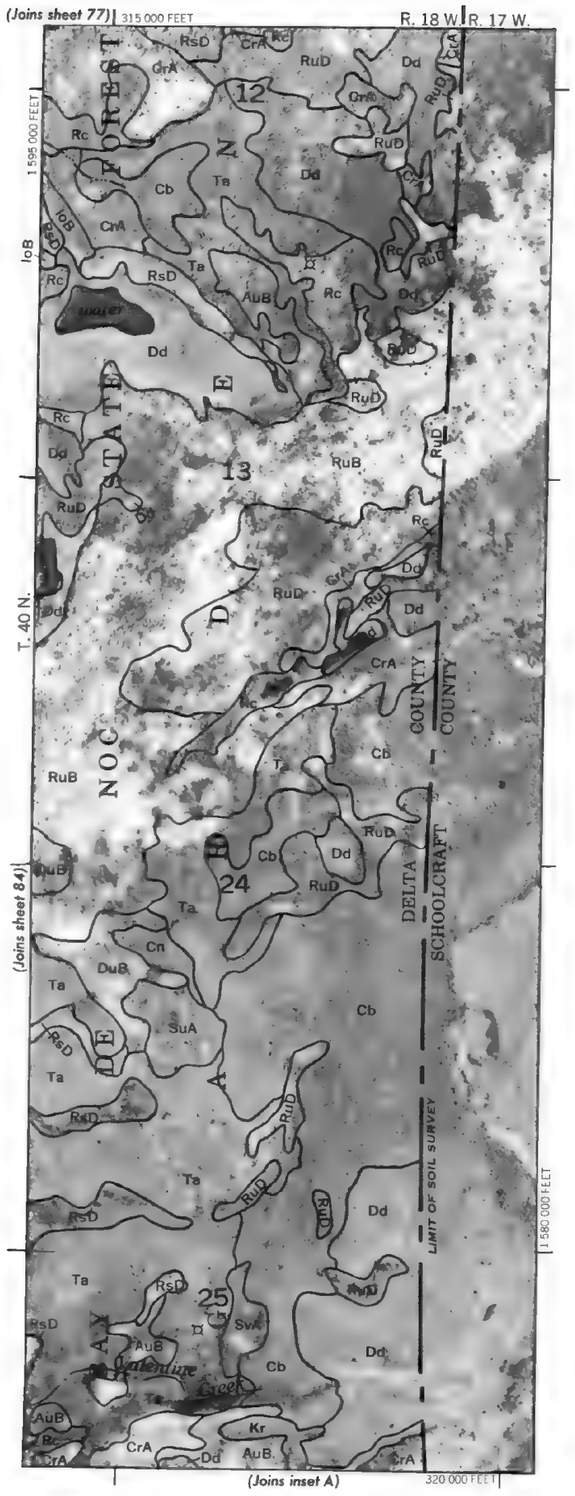
DELTA COUNTY AREA, MICHIGAN NO. 83

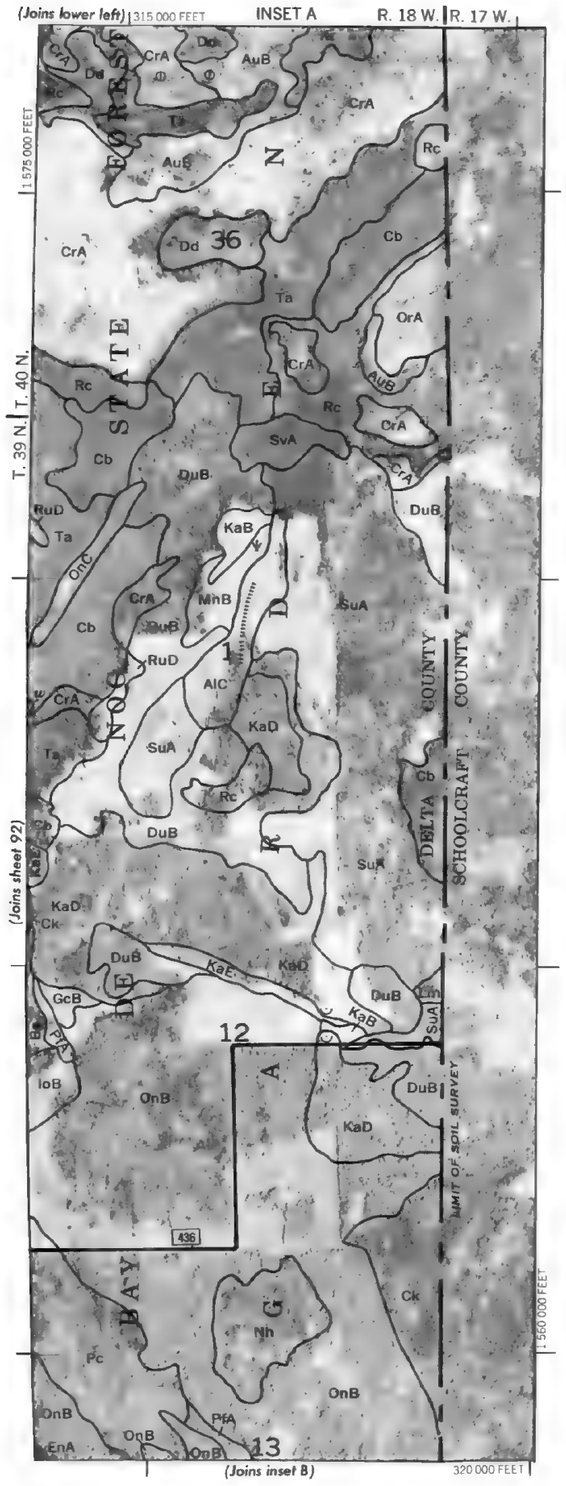
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 84





N

2 Miles

10000 Feet

Scale 1:24000

DELTA COUNTY AREA, MICHIGAN NO. 85

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

N

2 Miles 10000 Feet 1 5000

Scale 1:24000

0 0 1000 ¼ 2000 ½ 3000 ¾ 4000 1 5000

R. 24 W. (Joins sheet 69) 110 000 FEET

1 595 000 FEET

T. 40 N.

(Joins sheet 78)

100 000 FEET

(Joins upper right)

1 580 000 FEET

R. 24 W. (Joins lower left) 110 000 FEET

T. 39 N. | T. 40 N.

(Joins sheet 87)

100 000 FEET

(Joins sheet 99)

WaA

DELTA COUNTY AREA, MICHIGAN NO. 86

DELTA COUNTY AREA, MICHIGAN NO. 87

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

R. 24 W. | R. 23 W.

T. 40 N. | T. 39 N.

115 000 FEET

1 580 000 FEET

1 565 000 FEET

135 000 FEET

(Joins sheet 78)

(Joins sheet 88)

(Joins sheet 86)

(Joins sheet 93)

N

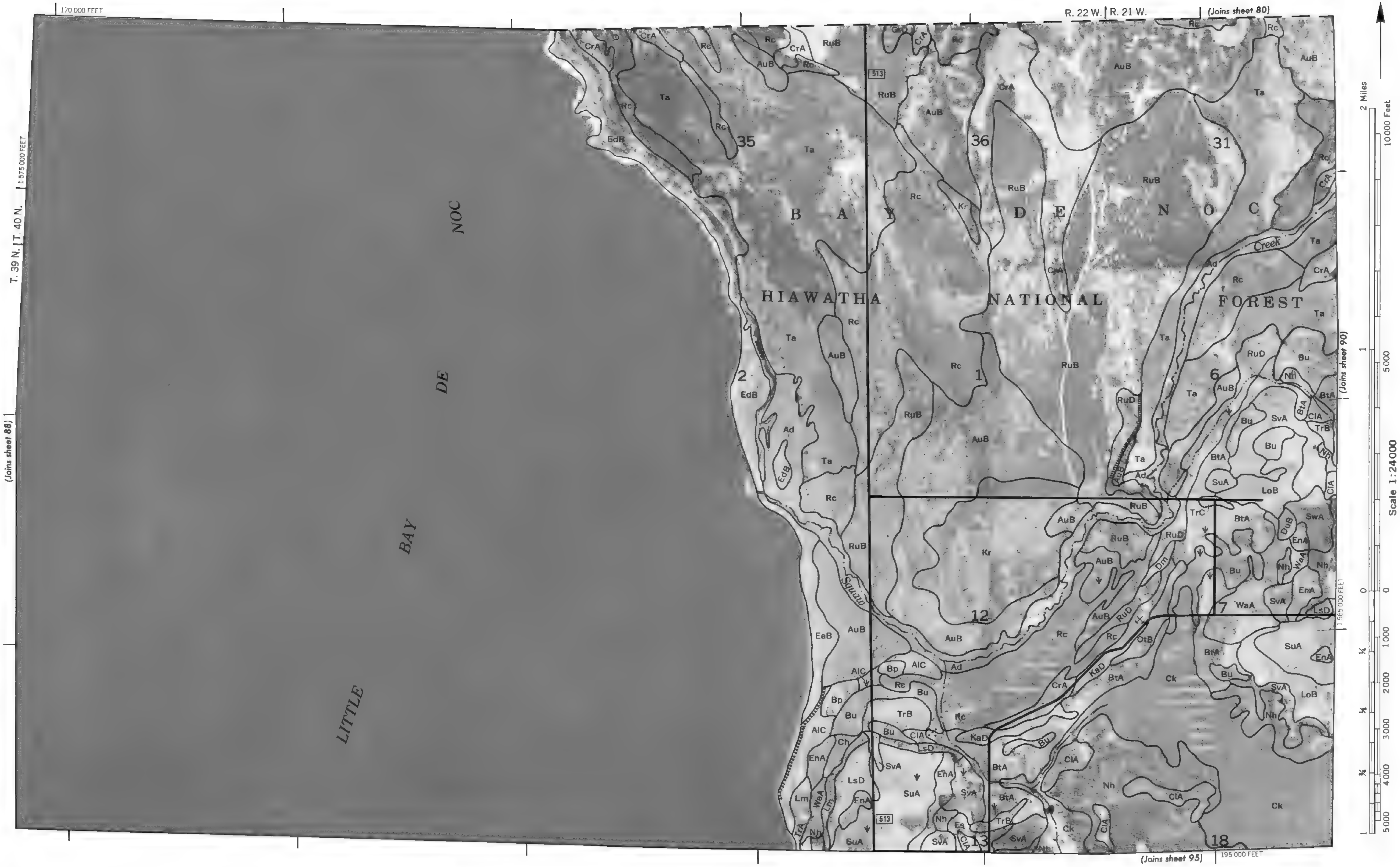
2 Miles

10000 Feet

1 5000

Scale 1:24000

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



DELTA COUNTY AREA, MICHIGAN NO. 89

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 9

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

290 000 FEET

R. 18 W.

(Joins sheet 4)

T. 47 N.

T. 46 N.

1 795 000 FEET

(Joins sheet 8)

(Joins sheet 13)

315 000 FEET

1 785 000 FEET

HIAWATHA NATIONAL FOREST

LIMIT OF SOIL SURVEY

NATIONAL FOREST BOUNDARY

Miners River

Lake Superior and Shpeming

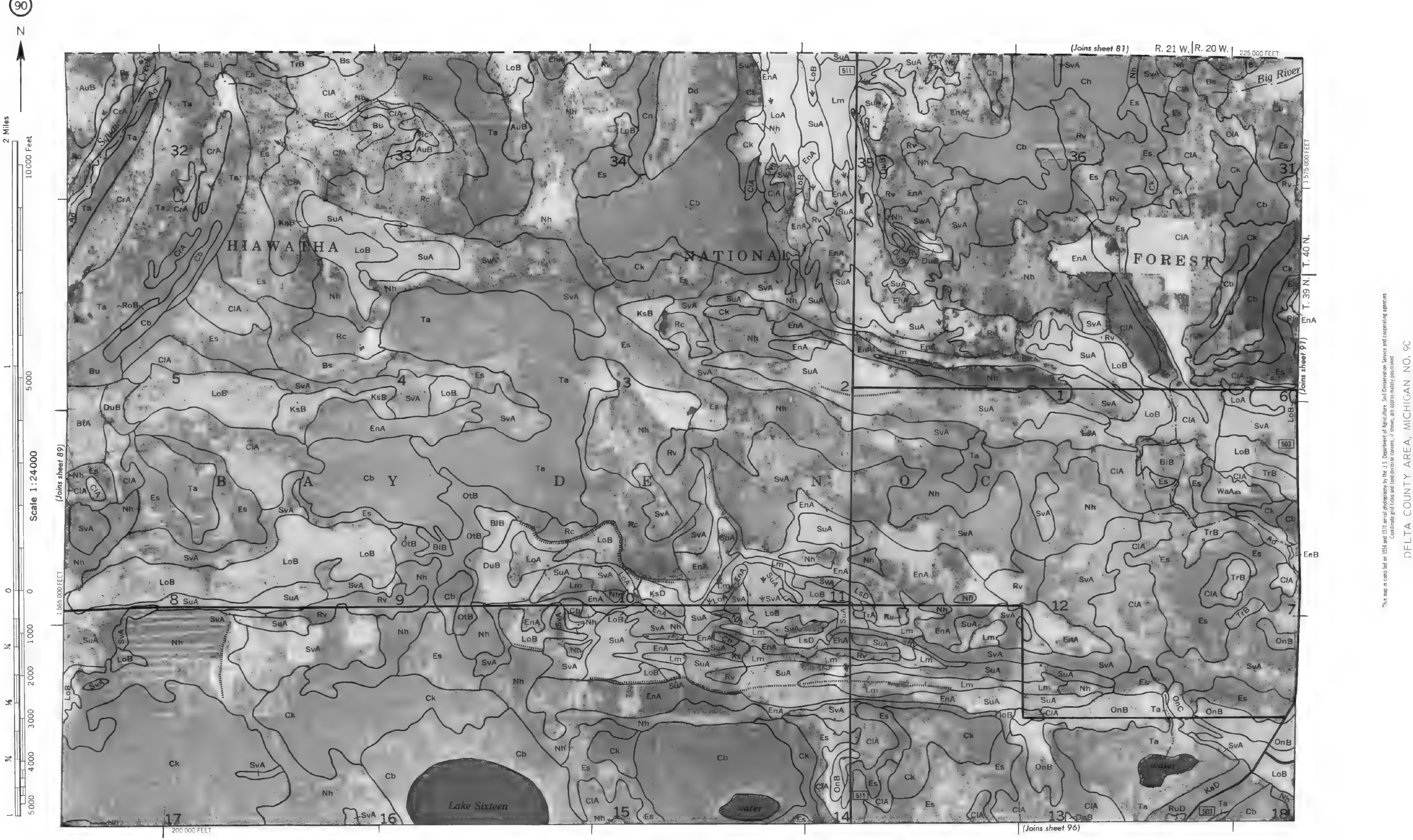
9

N

2 Miles

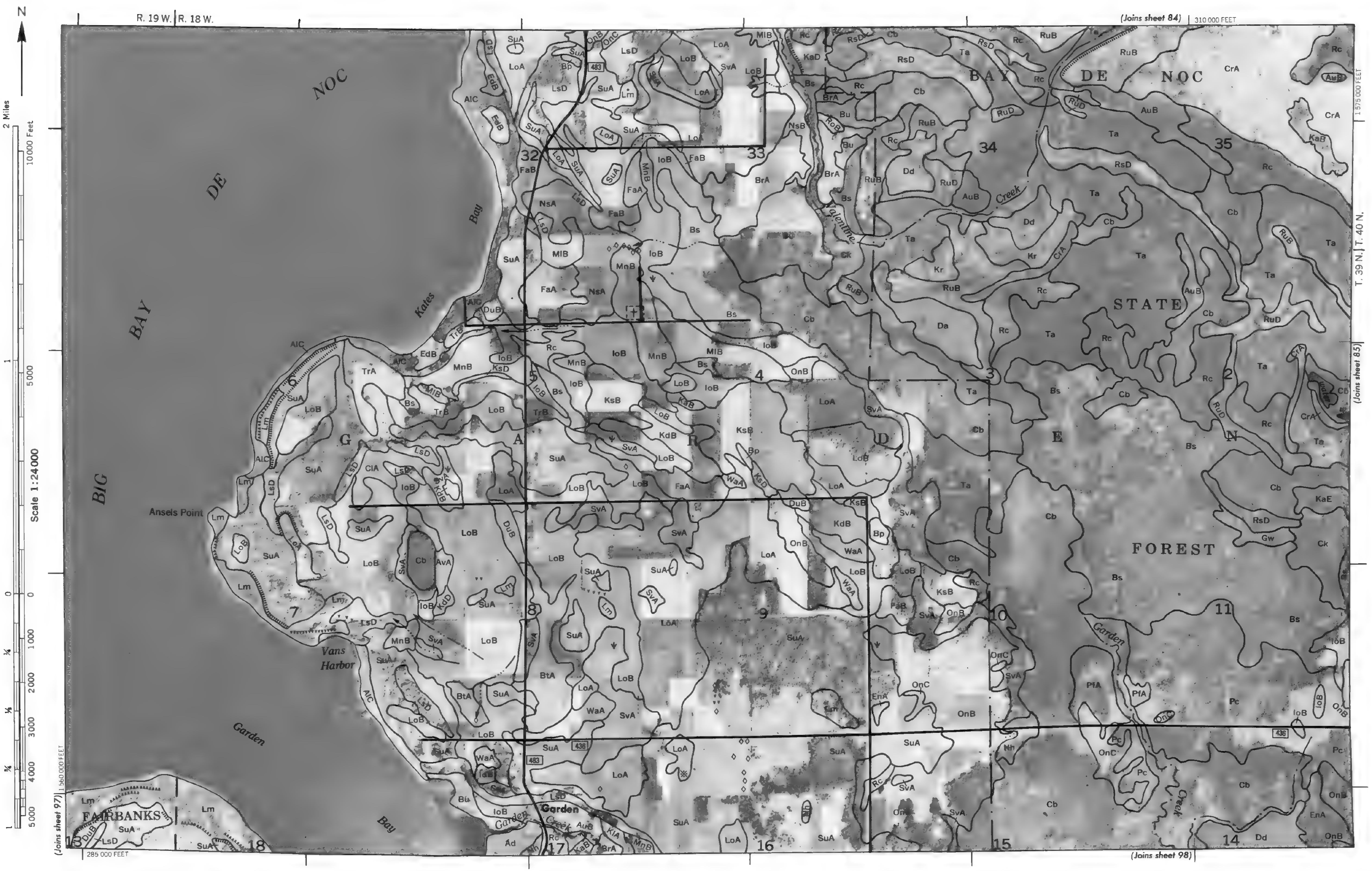
10000 Feet

Scale 1:24000


90
N
(Joins sheet 81)
R. 21 W.
R. 20 W.
225 000 FEET
1 575 000 FEET
T. 40 N.
T. 39 N.
(Joins sheet 97)
(Joins sheet 96)
(Joins sheet 89)
200 000 FEET
1 565 000 FEET
Big River
HIAWATHA NATIONAL FOREST
BAY DE NOC
Lake Sixteen
water
Scale 1:24000
2 Miles
1
0
10 000 Feet
5000
0
1000
2000
3000
4000
5000
DELTA COUNTY AREA, MICHIGAN, NO. 90

DELTA COUNTY AREA, MICHIGAN NO. 91
This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

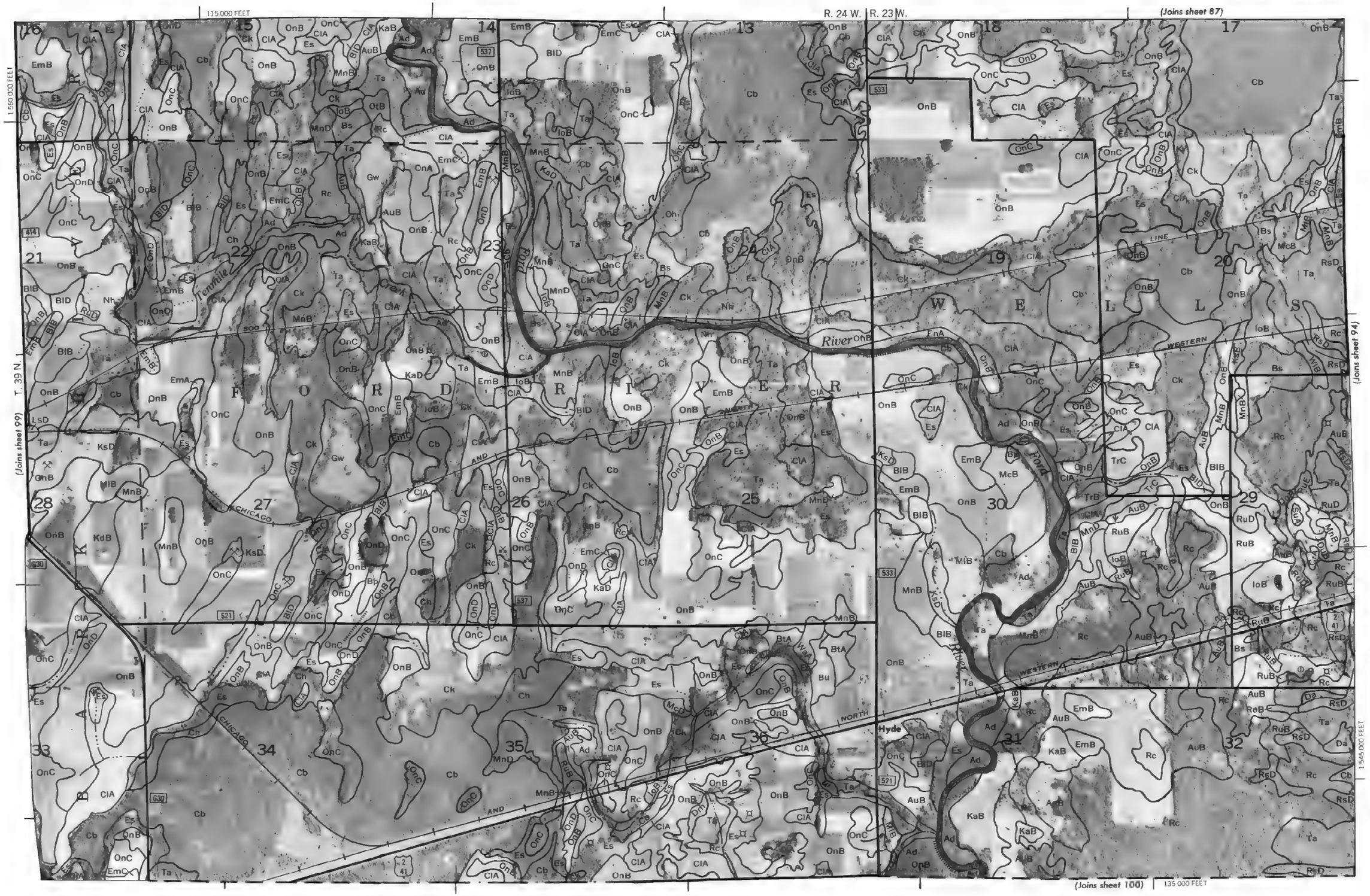
92



This map is compiled on 1954 and 1970 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

DELTA COUNTY AREA, MICHIGAN NO. 93

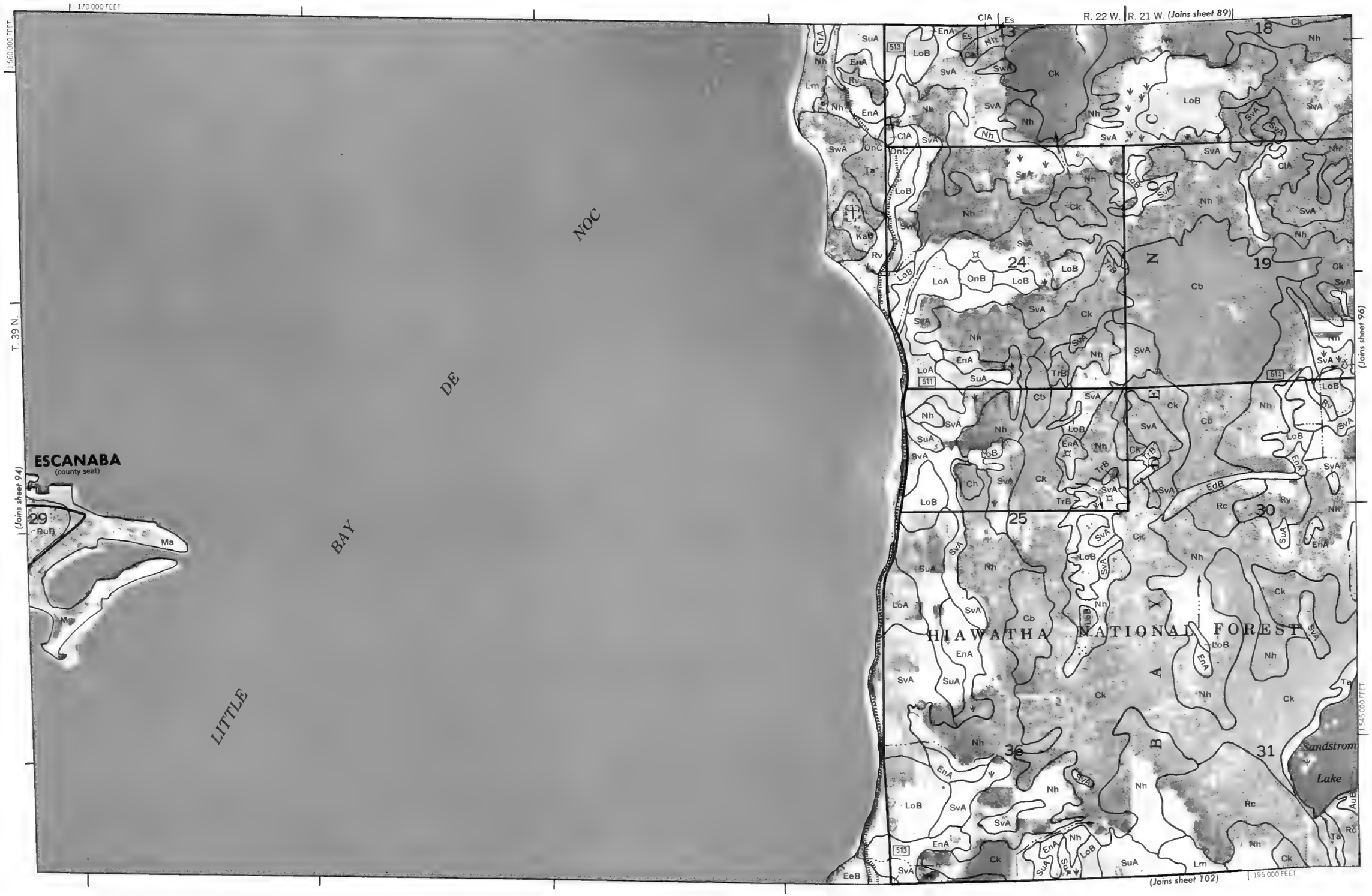
This map is compiled on 1954 and 1970 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid lines and land division corners if shown are approximately positioned

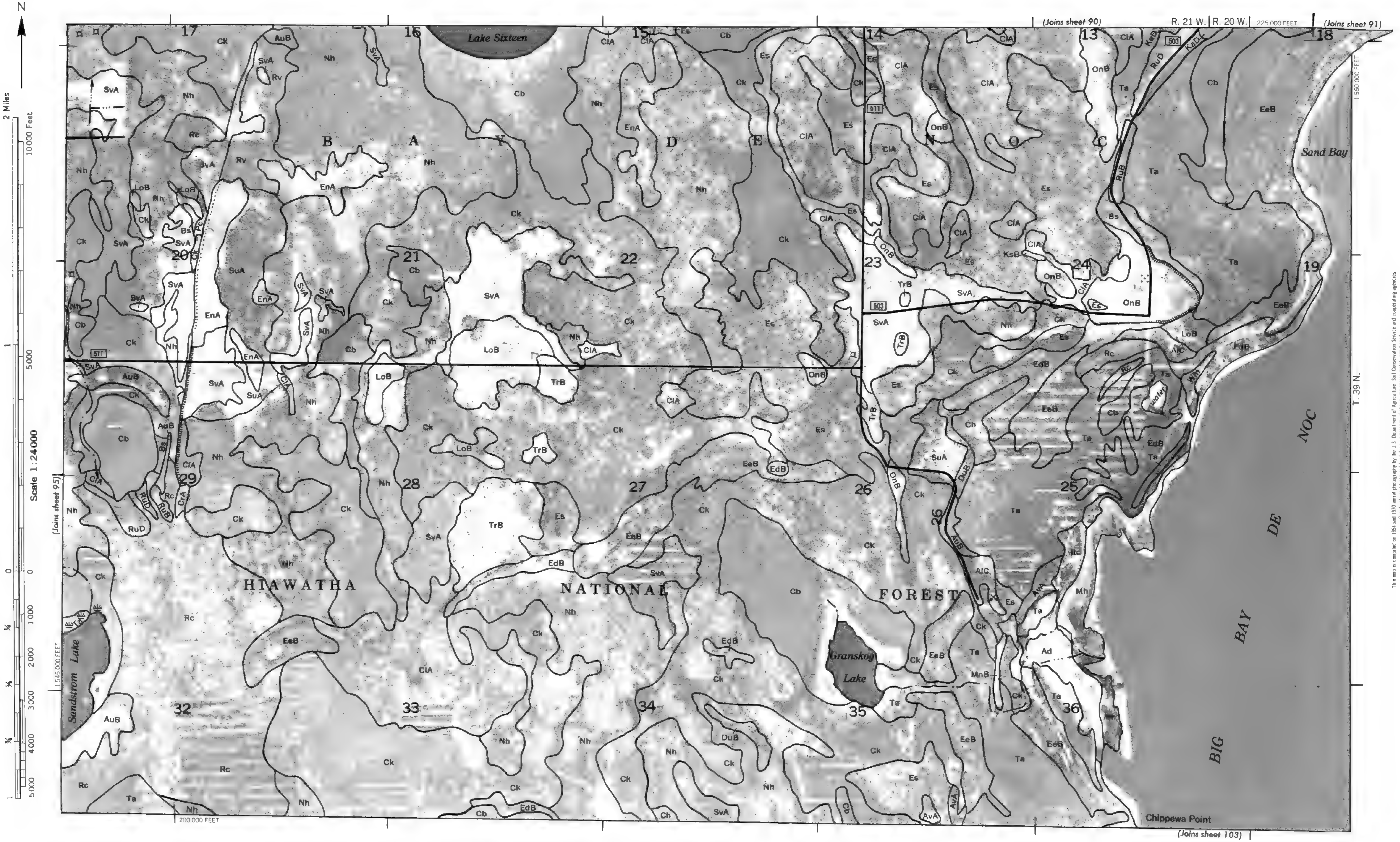


N

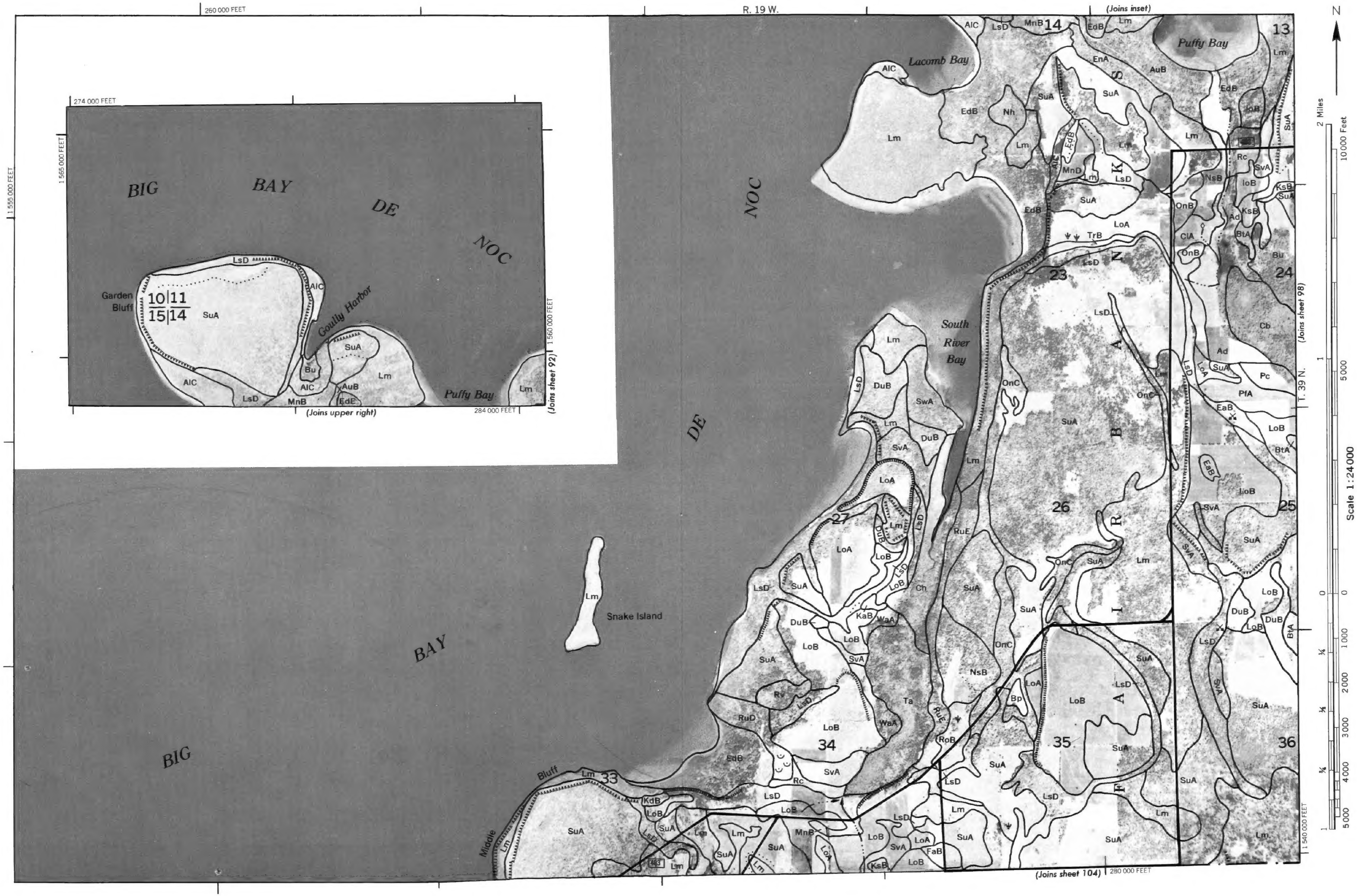
Scale 1:24 000

This map is compiled on 1964 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



DELTA COUNTY AREA, MICHIGAN NO. 97

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

98

N

R. 19 W. | R. 18 W.

(Joins sheet 92)

310 000 FEET

1 555 000 FEET

(Joins sheet 85)

T. 39 N.

(Joins sheet 97)

1 540 000 FEET

285 000 FEET

(Joins sheet 105)

Scale 1:24000

2 Miles | 10000 Feet | 5000

Garden Bay

Portage Bay

Cb Creek

water

LAKE MICHIGAN

BAY DE NOC

STATE FOREST

Berndt Point

This map is compiled on 1954 and 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

DELTA COUNTY AREA, MICHIGAN NO. 98

DELTA COUNTY AREA, MICHIGAN NO. 99
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